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The Public Lighting Tables of the American Meter Company will be found in the page advertisement of that Company.

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RETROSPECTIVE AND PERSPECTIVE.

When the current issue of the JOURNAL reaches its readers, many, if not all of them, will be engaged in collecting data for their yearly reports and considering such recommendations as they may deem proper to lay before their Boards of Directors for the ensuing year. Under such conditions, it will perhaps not be amiss on our part to review the happenings of the past twelve months, and to offer such suggestions as our observations lead us to believe will be of value to those interested in the manufacture and distribution of artificial gas.

The past year has witnessed the usual number of gas men in convention assembled, to discuss those matters bearing upon their profession, and we are happy to note that in point of attendance these laudable gatherings have received commendable support. A new association, local in its character but general in its objects, has been added to the list of older bodies. We feel that too much cannot be said in favor of these organizations. While in no way detracting from the membership or attendance of their co-workers, they bring before us incidents and views that would hardly be as generally disseminated were they not in existence. Time and expense are great factors to those of the fraternity who are removed from the large centers, and we should accord all encouragement and support possible to make these local gatherings permanent fixtures. We now have associations on the Atlantic and Pacific slopes, in the Central and Northern States, and in the far South. Because of this, we feel that valuable experiences that would otherwise lie dormant will be brought before us through the medium of the various papers and discussions, and that the workings of the gas profession, as conducted in the several sections of the country, will gradually become generally known, and bring about concerted action in matters affecting the profession as a whole.

We must deplore the unfortunate reticence upon the part of the younger and less experienced members. Discussions upon topics brought out, in what we know to be matters of the utmost importance, have been confined to a few, whereas, if they had been more thoroughly taken up and the why's and wherefore's sought after by those whose individual and company's interests would have been materially advanced thereby, would have been prolific of matter that the authors of the papers and the interested listeners would have collected and appreciated. We take the liberty of suggesting to these young members that their older brethren were not born graduates in the gas business. Their knowledge and experience were largely gained through the same channels that we now recommend to them. As a rule, the conventions are attended by those who are only too glad and willing to lend a helping hand, and whose only object is the imparting of knowledge, in a fraternal way, to him who has the courage to ask for it.

To those Companies that do not send their Engineers or Superintendents to attend these meetings, we would say that but few investments they could make would yield them such handsome returns. The outlay required is small, and the shrinkage it would occasion in the treasury is hardly worthy of consideration, even though no returns were immediately forthcoming.

In reviewing the various artificial lighting agents, we find little if

any change in the conditions. The latest recruit, acetylene, is, we may say, as far removed from being seriously considered a commercial success as it was a year ago. Some minor isolated installations have, we believe, been made, but with what success we have been unable to determine. This subject has been treated at length in our columns, and we have practically nothing to add to what has already been said. Rumors of large sums having been paid for State and Territorial rights have reached us. The truth of these statements we cannot authoritively confirm or deny. In electric lighting apparatus but little advancement has been made, and as a successful competitor to a good illuminating gas we need not longer consider it. But few of the electric light companies have been able to balance their profit and loss accounts to the satisfaction of their stockholders at the prices originally charged. In consequence, the rates have been raised and the severe and ruinous competition to which both sides have been subjected has almost ceased. Illuminating oils seem to have reached their highest standard, no new grades having been placed upon the market.

Under the conditions, we believe that perfection has been reached in refining, and from present indications we may say that substantial advances in prices may be looked for.

In the matter of lighting appliances we are pleased to record noticeable improvements in gas burners. The Welsbach burner has gained many admirers among the gas consuming public, and it is, in our opinion, a matter of but a short time until it comes into general use. We are rather surprised to note the misgivings with which its introduction is viewed by some gas companies. We have heard the fact bemoaned that the installation of a Welsbach burner meant a decided decrease in consumption. We will admit this, but it certainly strikes us that no gas man who is fair and unbiased will view the burner in any other light than that of a "blessing in disguise." With the powerful weapon that it proves to be against other means of illumination, we believe that classes of consumers who were beyond reach by reason of the increased cost of gas over oil, or because of its supposed inferiority and expense as compared to electricity, can now be approached and their former objections overcome, securing custom that would probably not have been secured were it not for the Welsbach burner. We are sorry to note that the manufacturers of this burner still adhere to their policy of paying enormous dividends and maintaining the almost excessive prices asked for their wares. We take it that the margin of profit must indeed be large, and we would deem it but fair and just if some little concessions were made to those who must necessarily, especially in small towns, be the means of making its introduction a failure or success. We believe in the policy of making such appliances a necessity and not a luxury, and trust that the day is not far distant when the manufacturers will arrive at the same conclusion.

What we have said of the cost of Welsbach burners applies also to the cost of gas engines. Gas power is a field as yet unworked. We are satisfied that as a means of increasing the consumption and keeping the mains in use regularly throughout the day, no other appliance on the market can equal the gas engine. Why such extraordinarily high prices should be asked is still a mystery to us. Increased sales in other lines of machinery uniformly mean decreased cost of production, and we see no reason why this should not be the case here. While we do not wish to dictate the business policy of any manufacturer, we feel that we may be pardoned for offering such suggestions as will be mutually beneficial to the producer and the user. In these days of sharp competition, it means a long pull, a strong pull, and a pull together, to make business a go, and unless this policy is pursued, it means a falling into a rut, with nothing but stagnation as a possible outcome.

Perhaps next week we will have something further to say regarding other topics that have not been here touched upon.

NOTES.—It is reported that Mr. John E. McElroy has resigned as Secretary, Treasurer and Director of the Municipal Gas Company, Albany, N. Y.——Mr. S. R. Newman has been elected Assistant Gas Inspector at Richmond, Va., to fill the vacancy caused by the resignation of Mr. Joseph E. Batkins.——Escaping gas in the meter room of the Citizens Gas Company, Buffalo, N. Y., on the morning of December 8th, caused an explosion and the fatal burning of Dennis Hutch, a foreman, and William Manning, laborer.——It is stated that Governor Morton has accepted the resignation of Anthony Clinchy, State Inspector of Gas Meters in this city.——The Providence Gas Company has fulfilled its offer to pay $2,500 each to the families of the firemen who were suffocated last spring in the gate house of one of its large gasometers.——A communication was recently laid before the Board of Public Works, of Kansas City, Mo., recommending that amendments be included in the West Side street railway trolley franchise, requiring that protection be furnished to gas and water mains against electrolysis. This has for its object holding the trolley line liable for damage to gas and water pipes caused by runaway electric currents, and requiring the method of construction of the road to be governed by the latest approved rules to prevent electrical damage to pipes.——B. G. Dawes, President of the Lincoln Coal Company, of Lincoln, Neb., has been elected Secretary of the La Crosse (Wis.) Gas Light Company.

[Prepared for the JOURNAL.]

Naphthaline: The Causes of Its Formation and Means for Its Prevention, in a Free State, in Illuminating Gas.

By Mr. CHARLES P. RUSSELL.

In subjecting coal to the process of dry distillation, as practiced in the manufacture of illuminating gas, in addition to the coke and the incondensible gases which, after going through the various processes of purification, are sent into the holders, there are formed through the various reactions between the disengaged principles of the coal, many other products, varying necessarily more or less in quantity and character, according to the quality and condition of the coal used and with the divers circumstances under which the distillation is carried on. Many of these newly formed bodies—all being volatile—condense with tar.

The composition of this tar is, of course, subject to some variation, dependent upon the temperature under which the distillation of the coal is effected. Under the higher temperatures the yield of solid bodies and gases will be greater; under low temperatures the liquid portion of the tar is appreciably increased in amount. In distilling the tar we obtain varying proportions of a number of products, which may be classified in the three divisions of liquids, gases and solids. I will here treat of the latter only, as in that division we find naphthaline, the subject of this article.

Naphthaline is a white, shining, crystalline substance, fusing at 176° F. and boiling at 423° F., but volatilizing when brought in contact with steam. It is not soluble in water, but readily dissolves in alcohol, chloroform, naphtha, ether or carbon disulphide. Its presence in a free state in illuminating gas is very annoying, both to the producer and the consumer, and should be carefully guarded against. In the former case it effectually blocks the passage of the gas from the generating apparatus to the holder, causing stoppages and back pressure in the train of apparatus, and very often necessitating the complete closing down of the plant. Owing to its tendency to develop, particularly in cold weather, when, perhaps, the works are being pushed to their utmost capacity, the importance of detecting it and preventing its crystallization, is evident. Aside from the disadvantages above enumerated, the candle power of the gas is materially reduced, and if the crystals form outside of the works, in the distributing system of mains and service pipes, we are confronted with a batch of complaints from our consumers that is certainly disheartening.

As soon as this annoying impurity—if I might so term it—gives evidence of its presence, the cause thereof should be immediately sought for and corrected. The condition of the coal should first be looked after. The use of wet coal—particularly if slack—should be avoided. This is probably one of the most fruitful sources of our trouble, and too much stress cannot be laid upon the necessity of keeping the heats in the retorts as nearly even as possible. Being convinced from my experience with this troublesome substance that its formation can be checked before the gas leaves the generating apparatus, I will state some reasons for my convictions. In operating one of the plants of which I was in charge several years ago, we were suddenly called upon to supply a much larger quantity of gas than usual, owing to the electric light plant being shut down and unable to furnish light. Our bench capacity was limited, and it became necessary to run much larger charges of coal per retort than had been our practice. Notwithstanding the facts that the duration of the charges was the same, that the heats were kept up to the usual degree, and that the charges when drawn were thoroughly burned out, we began to experience trouble from naphthaline. This seemed strange, and caused me to closely investigate what occasioned the deposit. After a few days the electric plant resumed operations and we returned to our normal output. The quantity of coal charged per retort was reduced to what it previously had been, and no further deposits of naphthaline were experienced. The weather conditions—temperature, barometric pressure and precipitation—were practically the same during the period of my observations. This proved to me conclusively that, although the outward indications showed the process of distillation to have been regular in both the light and heavy charges of coal, the resultant gas did not leave the mouthpiece in as perfectly fixed a state when the heavy charges of coal were carbonized. I therefore believe that if in carbonizing the coal the weights are so fixed that the travel of the gases, resulting from its distillation, will be gradual through the retorts, giving them time to remain subjected to the full action of the heat in the retorts, the hydrocarbons will be so thoroughly fixed that there will be little or no danger of naphthaline deposits.

The argument may be advanced that this method of operating would necessitate an increase in the number of benches under fire, and a consequent increase in the cost of production. This is in a measure true, but I am satisfied that if the additional amount thus expended is compared with the loss incident to stoppages in the works and the reduction in consumption, should such stoppages occur in the mains and services, the balance will be decidedly in favor of additional benches.

Assuming that a works is handicapped in the matter of bench capacity, and that the generating apparatus is being operated to its utmost, one must look to other methods than the above to overcome our troubles. This may be done effectually in the condensing apparatus, and by carefully and systematically noting and recording the conditions any serious trouble from naphthaline deposits can be avoided. The writer was located at a point where extreme temperature conditions are frequently encountered. Sudden changes were the rule rather than the exception, the thermometer often falling 20° in as many minutes. Bench capacity was at a premium, and the demand for gas was generally upward in proportion to the downward tendency of the mercury. Consequently the condensing apparatus was frequently called upon to do the work that I would have much preferred to have spared it had additional retorts been available.

In operating the benches, when the retorts were in action, the use of the dip pipe in the hydraulic main was dispensed with. The gas was taken directly from the retorts through a bye-pass arrangement clamped to the bridge pipe and flanged to the top of the hydraulic main, worked by a system of levers from the retort house floor. This brought the gas to the exhauster at a temperature ranging between 110° and 120° F. The exhauster was speeded up by means of a connecting pipe with a check valve conveniently located, so as to cause the gas to be returned from the outlet to the inlet of the exhauster as many times as possible without affecting the pressure on the retorts. This pressure was maintained at 5-tenths. The gas, being made to come in contact with the blades of the exhauster more freely and under higher speed than is usually the practice, was deprived of a large quantity of its tar and heavy hydrocarbons, and was in condition, on leaving the exhauster, to be effectually treated by the condenser and rid of all the remaining tar. The condenser was of the Pelouze & Audouin type and was placed immediately after the exhauster. The gas at the inlet test cock showed a decided "tar stain." The counterweights on the invert were adjusted to operate the machinery under a differential pressure of 20-tenths, which by experience I believe to be the most successful practice. The gas at the inlet showed an average temperature of 110° F. The test cock on the outlet proved the gas to have been entirely stripped of its heavy tar, and showed only a light vapor stain on the test paper. The thermometer indicated a drop of about 5° F. as a result of the mechanical condensation. From the P. & A. condenser the gas entered a washer, the interior arrangement of which was a series of vertical, corrugated, perforated plates so constructed that the perforations were diagonally opposite and the corrugations overhung each other in such manner as to receive the drippings from the liquor feed pipe and present a constantly wetted surface to the gas in its serpentine passage through the apparatus. The inlet to this washer was similar to the ordinary dip pipe, submerged in the liquor drained off the plates; the dip being adjusted to work the apparatus under a differential pressure of 25-tenths. Upon leaving the washer, the gas was subjected to thorough desiccation in a dry lime purifier, which I may here state I believe to be the most efficient means of arresting the formation of any naphthaline crystals. Beyond this point I never found any indication of naphthaline, and I am positive that the same satisfactory result will be obtained wherever this practice is followed. The scrubber came next in order, then the multitubular condenser, the purifiers, station meter, and the holders. Opinions differ as to the proper arrangement of the apparatus. The arrangement as I have outlined it, I know, is somewhat of a departure from the ordinary, but my results were so satisfactory to my stockholders, my consumers and myself, that it would take some very convincing arguments, backed up by corroborative figures, to assure me that any improvement could be made.

Before concluding this article, it would perhaps not be amiss to give a few simple and effective tests whereby the presence of naphthaline may be detected when not apparent to the eye in the form of crystals. The liquor from the hydraulic main, condensers or scrubbers, when reddened by a solution of nitric acid, supersaturated with muriatic acid, will show the presence of naphthaline by tingeing a strip of fir wood of a rich purple color. Another test is to neutralize the liquor with dilute sulphuric acid. If naphthaline is present the liquor assumes a rose color and the sulphate solution gives off the peculiar odor distinctly characteristic of naphthaline.

These remarks apply to water gas as well as coal gas, whether the process is of the straight generator type or the carbureting is done in fixing benches. Overtaxing any type of generating apparatus will be equally prolific in causing naphthaline deposits, and if the gas is allowed to get away in an imperfectly fixed state we may expect trouble either around the works or in our main and service pipes.

It is hoped that this article will be of value to those who are confronted with naphthaline stoppages. The results given are those obtained in actual practice and are not based solely upon theory. The remedies are simple and comparatively inexpensive, and if the sugges tions made are followed out, every claim will be freely and satisfactorily substantiated.

Keeping Up the Gas Supply Without a Gasholder.[1]

By C. Ernest Stevenson.

A question having been asked in the columns of the *Journal* as to the feasibility or otherwise of keeping up the gas supply to a town without the use of a holder, it has been thought that a reference *in extenso* to the instance in the author's experience in which this was satisfactorily accomplished, would be of interest to the readers.

The instance occurred in the year 1890, in connection with the establishment of a gas works in the Argentine town of Paranà. The author had acted as Engineer in the construction of the gas works, which had been opened without any hitch in February of that year. The gasholder was a two-lift one, 60 feet in diameter, in a cast. iron tank. The inlet and outlet pipes were connected in the manner usual with such tanks, by duckfoot bends underneath the tank; the bends being bolted through to stand-pipes inside the tank. About six months after the opening of the works, in July, the joint of the bottom flange of the outlet stand-pipe gave way, and the water in the tank flooded the mains. A temporary connection was immediately made between the inlet pipe and the outlet pipe in the ground outside the tank, and the outlet valve closed; and the supply was continued through the inlet pipe. The Directors of the Company, however, desired to have the outlet pipe repaired, and consulted the author regarding the steps to be taken to effect this. As the joint was inside the tank, it was impossible to repair it without emptying the tank. To stop the supply of gas for this purpose would have seriously prejudiced the Company with its consumers; and it was therefore determined to attempt to continue it without the holder.

At the time the accident occurred, the consumption of gas was about 60,000 cubic feet a day; there being two settings of six retorts each fully at work. Before commencing the experiment, it was necessary to put additional retorts into action, sufficient to produce gas at a rate equivalent to the maximum draught on the mains in the heaviest hour of consumption. The amount of maximum draught was arrived at by observing the make of gas and the delivery from the holder during each quarter of an hour of the evening; and it was estimated that one additional setting of retorts would just suffice for the purpose.

When this setting had been heated up and brought into full working order, preparations were made for the experiment. First of all, the day before commencing it, all the purifiers were emptied and recharged with clean oxide, and during that night the charging of the retorts was suspended in order to empty the holder. During the next day only two retorts were charged alternately, and it was found that the gas they produced was just sufficient to balance the day consumption at 5-10ths pressure, the gasholder remaining stationary, although still afloat. A pressure gauge was fixed in the retort house communicating with the leading main, so that the pressure in the mains could be observed. The gasholder was then shut off, the bye-pass valve of the governor opened, and the governor itself thrown out of action; and supply direct from the retorts commenced.

As the time of sunset approached, the author stationed himself at the gauge in the retort house, and, the stokers being ready assembled, with coal laid down for charging all the retorts, as soon as the pressure began to fall, the order was given to charge one retort after another—the rise and subsequent fall of pressure being noted between each charge, until several retorts were under way. It then became necessary to pause for a time, for the production of gas from the retorts already charged continued to develop, and the pressure to rise. It was not long, however, before more retorts were required, and the charging was continued until all were at work. The danger to be feared was either that the pressure would increase too rapidly and blow the water out of the consumers' meters, or that it would fall too low and a defi-

1. *London Journal*, Nov. 30, 95.

cient supply occur. By care in charging it was found possible to prevent the former occurrence, and when all the retorts were charged it was found that a pressure of about 20 10ths was maintained throughout the remainder of the evening.

As the consumption fell off before midnight, a reduced production was necessary, but as the retorts had been charged at different times, extending over a period of two hours between 6 and 8 o'clock in the evening, the diminution in the production as the charges became exhausted was so nearly equivalent to the reduction in the consumption of gas that no difficulty was experienced. About midnight it was found necessary to recharge some of the retorts, to supply the gas consumed in the public lamps; and these second charges sufficed till daylight arrived—a pressure of about 10-10ths being kept up after midnight. The next morning the alternate charging of two retorts was reverted to, which again sufficed to keep up the day pressure of 5-10ths.

The first night's attempt having been successful, there was nothing to fear subsequently, except in the case of a sudden change of weather. Fortunately, however, the weather remained absolutely uniform the whole of the period during which the experiment lasted—not a cloud being once seen in the sky. The emptying and refilling of the gasholder tank, together with the repair of the joint, occupied 8 days, and at the end of that time the holder was again brought into action without the consumers being aware that anything unusual had taken place.

There were some circumstances that favored the success of the experiment, which might not be found in conjunction in this country. In the first place, the steadiness of the weather prevented fluctuations in the consumption day by day, which were also absent largely as a consequence of the residential character of the town. Secondly, the mains were of ample capacity for the draught put upon them. The leading main proceeded in a straight line for nearly a mile before entering the town, and there was a gentle rise the whole way, so that even if the pressure in the works had fallen to zero for a moment or two, there would still have existed pressure in the town. The long main of ample diameter formed a compensator for variations in pressure. Also a large proportion of the consumption was due to the public lamps, which, once lighted, continued to consume the same fixed quantity per hour throughout the night.

There is, however, one thing that would assist such an experiment in any town; that is the compensatory power inherent in the consumers' burners. These not being fitted with regulators, would be the cause of an increased or diminished consumption proportionate to the pressure, and would facilitate the establishment of an equilibrium if certain limits of variation were not exceeded.

One difficulty would arise if the experiment were very prolonged, and that would be connected with a change of purifiers. It would not be possible to preserve unbroken the day pressure when the purifiers were changed, unless the air in the newly filled purifier were allowed to go forward into the mains, which would probably produce a disastrous effect on the illuminating power of the gas when the time for lighting up came, for the air would remain together in a mass in the mains, and move forward in a wave when the draught set in. In a small township, however, if notice were given to the consumers, no serious objection would exist to the suspension of the day supply for a short time, during which the air could be blown out at the vent plugs of the purifiers. The time occupied in doing this would be too short to cause infiltration of air into the mains through loss of pressure.

It should be remarked that in the experiment recorded, care was taken in the first instance to have the retorts very hot, so that rapid evolution of gas commenced immediately they were charged. The standing off in the daytime itself brought about the condition of high temperature so necessary in order that the experiment should each evening be successful.

Experimental Method of Determining the Effective Center of the Light Emitted from a Standard Photometric Burner.

[Presented at the December Meeting of the American Society of Mechanical Engineers by Professor D. S. Jacobus.]

[NOTE.—As many engineers have to supervise photometric measurements, and the burner described herein is of the form often used for such work, the following method of determining the effective center of such a burner is considered of sufficient interest to many members of the Society to warrant presentation.]

In tests of car lamps made by the Department of Tests of the Stevens Institute during the past spring and summer, it was necessary to employ a burner of about 6-candle power as a standard of light. The burner selected was a Sugg Argand gas burner, size D, fitted with an opaque screen of the Edgerton pattern which passed over a glass chimney. The opening for the emission of light was arranged so that the top and the lower part of the flame were obscured from view, as shown in Fig. 1; whereas the horizontal width of the slot was made greater than the diameter of the flame. The horizontal width, *A B*, of the slot was 1¼ inches, and its height, *C D*, was ⅛ of an inch. The diameter of the opaque screen was 1¾ inches. The back of the screen opposite the slot was cut away so as to prevent reflected light from being thrown back and through the slot.

In this class of a screen and burner, the distances employed in calculating candle power measurements are often measured to the geometrical center of the flame. Any error so involved will be a small one, if the illuminated disc of the photometer is used at a considerable distance from the burner, and in about the same position which it occupied when the burner was calibrated by means of candles. In our tests,

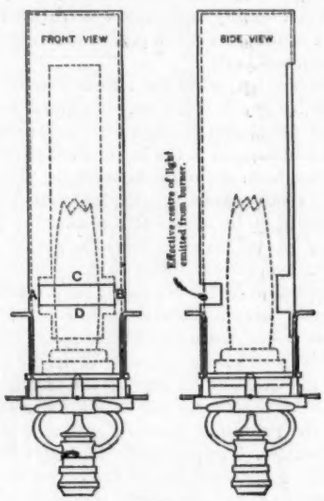


Fig. 1.

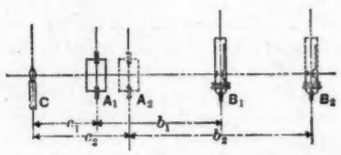


Fig. 2.

however, the burner had to be used in positions near to, as well as far away from the disc; so that it was necessary to determine the effective center of the light which is emitted.

The method of determining the effective center was as follows: The photometer disc was set at A_1, in Fig. 2, at a distance c_1 from the candles C, and the standard burner was brought to a position, B_1, at which there was an equal illumination on the two sides of the photometer disc at A_1. The distance, b_1, from the disc to the geometrical center of the burner was then recorded. The disc was then moved to another position, A_2, at the distance c_2 from the candles, and the corresponding distance, b_2, from the disc to the burner was recorded. The disc was then set back to its first position at A_1, and a second reading of b_1 obtained. It was then moved to A_2, and then back to A_1, and so on until a number of readings of b_1 and b_2 were obtained. After a sufficient number of readings was taken to eliminate any irregularity due to variations of light emitted from the candles, the results were averaged and the distance, x, of the effective light center from the geometrical center of the flame was found by means of the formula:

$$x = b_1 - \frac{b_2 - b_1}{\frac{c_2}{c_1} - 1}$$

The results of the experiments are given in Table I., and show that the effective light center of the burner was about $\frac{1}{16}$ of an inch from the geometrical center of the flame and entirely outside the flame as indicated in Fig. 1.

TABLE I.

Results of Tests to Determine the Distance from the Geometrical Center of a Standard Photometric Burner to the Effective Center of the Light which it Emits.

No. of Test.	Date, 1895.	Number of Sets of Readings Averaged.	Distances from Candles to Photometer Disc, in Inches. c_1.	c_2.	Average Distances from Photometer Disc to Burner, in Inches. b_1.	b_2.	Distance from Geometrical Center of Flame to Effective Light Center of Burner $= x$.
1	May 11	21	10	15	19.44	28.70	0.92
2	" 24	15	10	15	18.77	27.71	0.89
3	" 24	9	7	14	12.95	25.00	0.90
4	" 24	9	9	13.5	16.76	24.70	0.88
5	" 28	30	10	15	18.44	27.82	0.88
					Average.....=		0.89

The candles do not have to be corrected for variations in the rate at which the paraffine is burned. All that is necessary to insure accuracy is to make a number of observations, changing the distance of the photometer disc from the candles each time a reading is taken, as has already been explained, and employing the average figures in the formula. When this is done any variation of the light which is emitted by the candles during the test will affect the average values of b_1 and b_2 in such a way as not to alter the value of x.

The error involved, if all measurements were made from the axis of the burner instead of the effective center, both in calibrating and in using the standard burner, would have been as a maximum about 10 per cent. in the lamp tests which we made. In these the effective center of the burner was placed at a distance of 60 inches from two standard candles in calibrating the burner, and the minimum distance at which the burner, when used as a standard, was placed from the photometer disc, was about 12 inches.

An ordinary way of using the burner is to place it 60 inches from two standard candles to calibrate it, and then set it 60 inches from the flame of which the candle power is to be determined, all distances being measured from the axis of the burner. If calibrated and used in this way, there is an error of about 3¼ per cent. for a flame of 20-candle power, and of about 6 per cent. for a flame of 40-candle power.

Another way in which the burner is calibrated is to measure the candle power of a uniform gas flame, first with candles and then with the burner, and repeat the two operations until an average figure is obtained. When this is done there is but a small error involved in measuring from the axis of the burner, provided the gas flame which is measured is of about the same candle power as the flame which was employed for calibrating the burner, so that the distance from the standard burner to the photometer disc is about the same in both cases. If the burner is calibrated at 60 inches from a gas flame of 24 candles, and is used at the same distance to measure the intensity of a flame of 16-candle power, there will be an error of about 1 per cent.

A New Holder with Wire Rope Guiding.

The London *Journal*, in its issues for October 29 and November 26, gives the following particulars regarding the new gasholder at the Middlesbrough gas works, a tender for the construction of which had been accepted by the corporation from Messrs. Ashmore, Benson, Pease & Co., Limited, upon the lines of their wire rope system of guiding and at a cost approximately of $70,000.

Exploration holes were sunk near the site of the proposed tank, when it was found that there was a bed of hard clay about 5 feet thick within a few feet of the present surface. Under the clay, the ground is of a very boggy nature, so it was decided to erect the tank on a foundation of 3 feet of concrete on the hard clay. This is extended to receive columns to guide the holder, should this system afterwards be determined upon. The tank is 186 feet 6 inches in diameter and 31 feet deep. It is made of steel throughout, the lowest tier of plates on the sides being ¾-inch thick—a sufficient strength to stand double the water pressure to which they will be subjected. The platform round the lip was designed for being 2 feet wide, but this was increased to 3 feet 8 inches, in order to give easy access to the pulleys for the wire rope guiding of the holder. The tank will contain 5,286,000 gallons of water, or about 23,600 tons.

The holder is in three lifts, of the following diameters: Outer, 184 feet; middle, 181 feet 6 inches; inner, 179 feet. Each is about 30 feet deep, thus giving a total capacity of 2¼ million cubic feet. The lifts are constructed in the ordinary manner with cups and dips. The crown, which has a rise of 9 feet, is on the non-trussed principle, being the usual method with holders of this size—that is to say, instead of the crown being supported on a trussed iron framework attached to the top curb, with the center post resting, when the holder is out of action, on the foundation in the tank, there are placed 83 wood uprights, "anchored" to stone bases. These uprights, braced by diagonal struts, are surmounted by radial arms kept in position by timbers shaped to suit the resting of the crown.

The weight of the holder will be 335 tons; of the tank, etc., 623 tons; of the water, 23,600 tons—making a total on the foundations of 24,558 tons, or a pressure of 1.15 tons per square foot. The weight of the foundation being 7,335 tons, there is a total weight of 31,893 tons.

The inlet and outlet pipes (30 inches in diameter) penetrate the bottom of the tank, and are embedded in pitch on concrete foundation. The 24-inch cast iron pipes connecting the gas inlets from the works to the holders, and also connecting the gas outlets from the holders to supply the town, converge to the governor house, which is being built in such a position, and with the connections so arranged, that it will serve for future holders.

The main feature of interest regarding this holder is the fact of its being the largest erected up to the present time without the usual guide framing; and it may be remarked at once that the system of rope control has proved itself capable of maintaining the holder in an absolutely

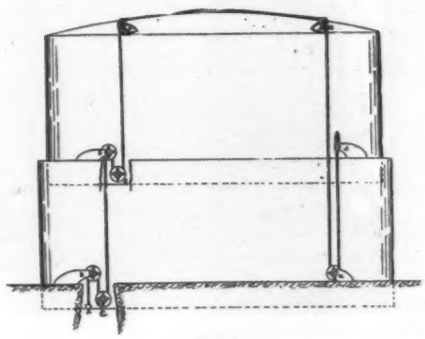


Fig. 1.

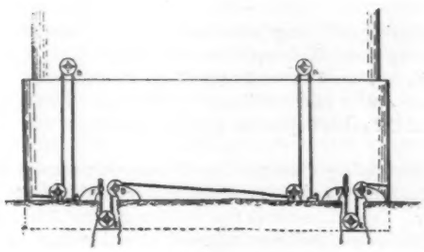


Fig. 2.

level condition, or, speaking more correctly, within half an inch. This was found to be the full amount of variation from the dead level when the holder was inflated to its full height and standing during a gale of wind, and working without any vibration or irregular movement. The pressure register also supplies an excellent diagram as to the regularity of pressure in the rise and fall.

Work on the tank was commenced in the beginning of December last year, water being turned in the first week of the following October, and the holder inflated on the 15th of that month. It may be mentioned here that the contract was signed on Oct. 12, 1894, and Messrs. Ashmore were allowed 16 calendar months for the completion of the work. They are therefore more than 6 months in advance of their time.

There is little to be noted with regard to the holder itself, as the design varies very slightly from that usually adopted, with the exception that a certain number of guides, with corresponding carriages, are placed on the outside. These prevent any twisting motion to which there may be a tendency by the action of the wind. The method of supplying the rope support, however, illustrates a development which has not previously been adopted—viz., the feature of the utilization of the power that is obtainable by the use of suitably placed pulleys. By this means, the 12 ropes that pass over the inner lift have, broadly speaking, the effectiveness of 24 ropes when applied to the second lift. The outer lift is roped quite independently of the two inner lifts. It is supplied with 18 ropes for the support of the bottom curb, and 18 ropes

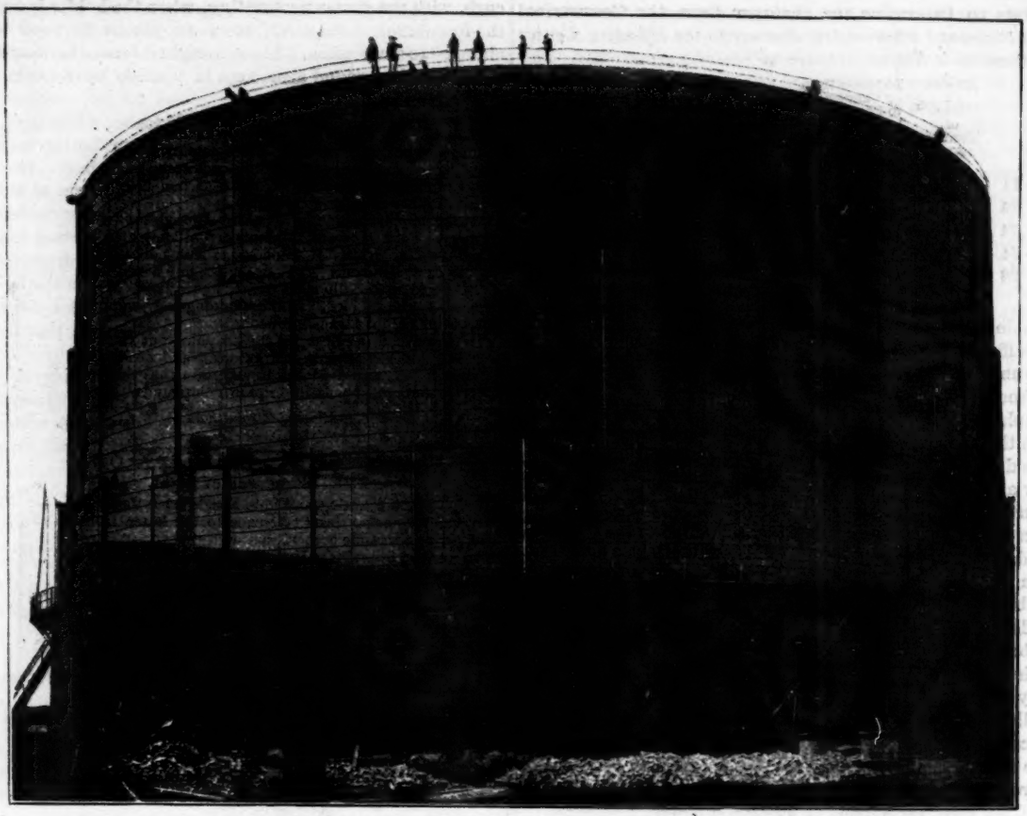


Fig. 3.—Rope-Guided Gasholder at the Middlesbrough Corporation Gas Works. Capacity, 2,250,000 cubic feet. Tank, 186 feet 6 inches diameter, 31 feet deep.

for the anchoring (if it may be so termed) of the dip of the outer lift, on the same principle as that applied to the second lift. The 36 ropes on the outer lift (or, more correctly speaking, 18, seeing that each rope acts in a double capacity in controlling the dip at one extremity and the bottom curb at the other) possess a gross aggregate effectiveness of 72 ropes.

The accompanying diagrams are in no way correct in detail, but merely to indicate the position of the pulleys and brackets in regard to one another. Fig. 1 illustrates the two inner lifts. The ropes cross the center of the crown, and are attached at either end in the manner shown by the two portions of rope which combined form one complete rope. As the inner lift rises, *E* approaches *D*, while *G* leaves *H*. When the outer lift rises, the two points *A* and *C* approach *B*, while the two points *G* and *J* leave *H*. The traverse of each rope is thus twice as rapid, and the support it is qualified to afford double as great, as in its passage over the inner lift. Perhaps it is hardly necessary to remark that a minimum of three ropes is necessary.

Fig. 2 does not show the horizontal pulleys that are required to carry the ropes round the circle of the holder. The number of parallel ropes on these pulleys will vary according to the distance apart of the two ends of the ropes and the number of ropes employed. In the present case there are four, which run for a certain distance in company. The essential principle of the arrangement is plainly shown in the diagrams, and needs no further elucidation. Attention may, however, be drawn to the means of adjustment, and to the springs on the tops of the brackets. Ample margin is left for tightening the ropes if required, and the effect on its neighbor of tightening one rope, owing to their juxtaposition, is very clearly shown. *A*, *C*, *D* and *F* are all fixed to the tank.

In all cases the brackets of the pulleys on the holder that receive the strain of the ropes are firmly attached to strong vertical stays on to the ironwork of the curbs, or cups and dips, in close proximity. Intermediate between the 18 stays carrying the pulleys corresponding to those marked *B* in Fig. 2, are 36 stays of lighter section. While the vertical stays provide for the stiffening of the outer lift, they also, to some extent, secure its vertical rise. Opposite to the 36 exterior vertical stays corresponding pulleys are placed on the top of the tank. These, in conjunction with the tank guides, have, irrespective of the ropes, a controlling power, which, however, decreases as the holder rises.

Cleansing Spent Oxide.

By A. E. Broadberry.

[Read before the Southern District Association of Gas Engineers and Managers, Eng., November 14th, 1895.]

It is with a considerable amount of diffidence that the author places before the Association the results of some small scale experiments, made at Tottenham, with a model apparatus which, though designed for use in another branch of commerce, is believed to be applicable to gas works for the extraction of sulphur from spent oxide, leaving the material in good condition for re-use. The diffidence is real; and it arises from the slight practical value generally, and properly, attaching to experiments of this class. Indeed, this paper would not have appeared at all had it not been understood that there would be no other paper forthcoming for this meeting.

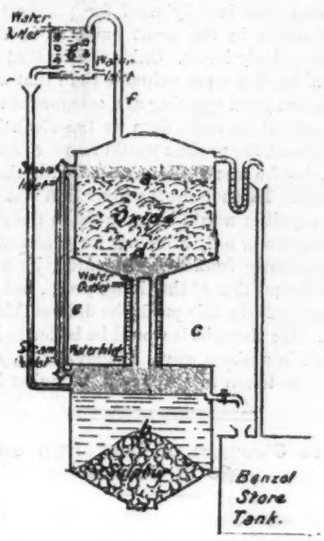
It had been hoped that the results of working with an apparatus dealing with a ton at a time would have been available; and on the strength of this a promise of a paper had been made. But, unfortunately, the machine was not ready in time; so that it became a question of either breaking the promise made to our esteemed secretary, or compelling you, gentlemen, to listen to an essay on possibilities, instead of a record of accomplished facts. The former alternative could not be entertained.

The subject, however, is one of sufficient importance to the industry with which this Association is identified to render it desirable that the opportunity should not be lost of making the members acquainted with the system; and it will, perhaps, be something in extenuation that the apparatus used (which was kindly lent by the inventors) is on a somewhat larger scale than is generally employed in the laboratory. As the oxide was in no way prepared, but was treated in its normal condition, it may be relied on that the results could be reproduced on any larger scale.

To faciliate the description of the apparatus, the accompanying sec-

tional drawing has been prepared, showing its arrangement. Its simplicity is at once apparent. The upper, or oxide, vessel, *A*, is connected to the lower or sulphur, vessel, *B*, by the water jacketed pipe, *C*, with the filter or strainer, *D*, above it to prevent particles of oxide from passing down. A further connection between the two vessels is made by the steam jacketed pipe, *E*. The ventilating pipe, *F*, is attached to a water cooled condenser, *G*, the condensation being returned to the apparatus. It will be noticed that, except for the stopcocks for steam, water, etc., and the doors for charging and discharging, there is an entire absence of cocks, valves, or working parts to be manipulated. In fact, the process of working is as simple as the apparatus itself.

The oxide to be treated is placed in the upper chamber—the lower one being about half filled with water—and then benzol or other similar solvent is put in up to about the overflow, entirely covering the oxide.



To set the apparatus in operation, all that has to be done is to pass a small current of steam into the steam jacket, and a flow of cold water through the water jacket and through the condenser. The heat communicated to the solvent in the pipe *E* induces an upward flow, and discharges it on to the top of the oxide in a heated condition—that is to say, at about 70° to 80° C. The return flow of the solvent is through the cooling pipe *C*, which has its central portion occupied by a cylinder, the better to expose the solvent to the cooling surface; and this deprives it of its heat, returning it to the lower chamber at about, say, 25° C. The circulation thus produced continues automatically, so long as the steam and cold water are supplied to their respective places.

Benzol, at its temperature of 70° to 80° C. in the upper chamber, will dissolve 2½ to 2¾ pounds of sulphur per gallon; but when cooled to 25° C., on its return to the lower one, it will retain only ¼ pound per gallon. It therefore follows that for every gallon circulating, whilst there is plenty of sulphur in the oxide on which it can act, over 2 pounds of sulphur are extracted from the oxide and deposited in the water at the bottom of the sulphur vessel. It will be seen that the principle of action is the different absorption of sulphur by the solvent at varying temperatures. Having filled the apparatus with spent oxide, water and solvent, and turned on the steam and water, the apparatus may be left to itself until the extraction has ceased, when the benzol is drawn off and the oxide thoroughly steamed, to distil and recover the benzol with which it is saturated.

For the following calculations the quantity of oxide treated was 20 pounds, and its analysis before cleansing was:

Water	11.2
Sulphur	54.0
Purifying material	34.8
	100.0

Or, calculated on the dry basis—

Sulphur	60.8
Purifying material	39.2
	100.0

The total weight of sulphur in the 20 pounds operated on is therefore calculated to have been 10.8 pounds, of which over 10 pounds were extracted by the process. The following is a test of the oxide after treatment:

Water	40.8
Sulphur	5.6
Purifying material	53.6
	100.0

Or, calculated on the dry basis—

Sulphur	9.5
Purifying material	90.5
	100.0

The water used in the water jacket and condenser was run into a tank and accurately measured. To ascertain the quantity of steam used, a condenser was placed on the steam outlet, and the condensation gave the amount of steam employed. The time occupied was 7½ hours, during which, except for noting the statistics necessary for this paper, no attention was required. The solvent used was benzol, carefully measured before and after the experiment, the loss being about 1 per cent.

Having described the apparatus and the method of working, it has now to be seen what commercial figures can be deduced therefrom. The value of 1 ton of spent oxide, 54 per cent. sulphur, at 4 cents per ton per unit, would be $2.24, less 12 cents for loading, or $2.12 net. The cost and revenue of applying this method to 1 ton is estimated in the following statement. The figures based on the working of the small machine are believed to be excessive on the *Dr.* side for one of larger dimensions.

Dr.		Cwts. Qrs. Lbs.	*Cr.*
Spent oxide, 1 ton	$2.12	10 0 16 sulphur, at $13.75	$6.97
Water, 2,016 gallons	.37	13 3 19 50 p.c. purifying material, at $7.50	5.20
Steam, 303 gals. water evaporated, at 2c. p. 10 gals.	.62		
Benzol, 1 p.c. on 400 gals.	1.00		
Labor (estimated)	1.50		
Profit	6.56		
Total	$12.17	Total	$12.17

The advantage to be gained may therefore be taken to be $6.56 per ton of spent oxide.

It may possibly be urged that, with the limited quantity of oxide in use in most gas works, the extra trouble makes "the game not worth the candle." In these days of sliding scales, however, with the attendant desire to reduce the price and, incidentally, increase the dividend, not only must every item of expenditure be watched, but the merest possibility of improved working, however small, must receive its fair share of attention, if it will appreciably affect the cost per 1,000 cubic feet. If, then, the calculation be made in this direction, it will be found that, estimating that one ton of oxide is used for every 2,000,000 cubic feet of gas made, giving 28 cwts. of spent, the saving would represent 0.44 cent per 1,000 cubic feet.

Attempts have previously been made for commercially extracting sulphur from spent oxide; the carbon bisulphide process being, perhaps, scientifically the most perfect. At the same time, practically it is highly dangerous; and probably no gas engineer would admit it on his works. The existence of carbon bisulphide in the gas is not sufficiently welcome to him to lead him to seek a further acquaintance. But with benzol and similar oils, he is already well acquainted in the enrichment of gas; and even should the vapors escape, they have a familiar odor, and do not cause that distress to the human system which carbon bisulphide does. On the other hand, should any be left in the oxide after the cleansing, it would merely tend to improve the candle power of the gas. [Samples of the cleansed oxide, and also of the extracted sulphur, were placed on the table for inspection.]

In concluding this paper, a few words of protest against a custom ruling in the oxide market will not be out of place. It is well known that quotations usually contain a clause providing that any percentage of water in excess of 50 per cent. will be deducted from the invoice—meaning, apparently, that one-half of the weight charged for is to be purifying material or an allowance will be made accordingly. Let it be assumed, then, that a delivery comes in containing 60 per cent. water. An allowance would be made of 10 per cent., which, at first glance, appears fair and satisfactory. But it is the solid matter, not the water, that it is desired to buy; and 60 per cent. water means 40 per cent. instead of 50 per cent. of oxide—four-fifths, or 80 per cent. The reduction should, consequently, be at the rate of 20 per cent.

It is, obviously, to the advantage of the sellers to make the moisture as high as possible; and it is rarely found that they fail to do so. When a reduction is claimed, and they allow it, they pocket an equal amount

themselves, or, in other words, allow only one-half of what they should. Besides this, there are doubtless many cases in which the moisture is not tested, and no claim made; and then the sellers have all, instead of half, of what should belong entirely to the buyer.

Taking the extreme case shows the folly of it; so let us assume that 100 tons of oxide are ordered, and the seller pumps 100 tons of water, pure and simple, into a barge and delivers it. The invoice would be made out as follows:

To oxide of iron ..... 100 tons.
Less excess of water, 50 per cent. 50 "
50 " at $7.50 = $375.

That is, $375 for 100 tons of water, and not a particle of oxide. It seems stupid, but it plainly illustrates the fact. One would naturally complain under such circumstances, but all the satisfaction one would get would be the reply, "We admit your point, but it is the custom of the trade, so we regret we can do nothing in the matter."

At Tottenham, for some years, attempts have been made, with varying success, to break the custom. Combined action by all the members of this Association would no doubt put an end to the iniquity.

Discussion.

The President (Mr. S. W. Durkin, Southampton) said they had heard a very interesting paper, and he would be glad to hear any remarks which members desired to make upon it. No doubt it would afford them food for reflection. If it answered their purposes to clean their own oxide they would not have to buy quite so much.

Mr. C. C. Carpenter, London, said the subject was one in which they were all interested, and for himself he cordially agreed with what Mr. Broadberry said, that in these days of cheap gas and sliding scales they could not afford to neglect anything which might enable them to work more economically. With reference to this method of recovering sulphur from oxide, it seemed to him a novel one, and he could not conceive an apparatus better fitted to carry out the object the author of the paper had in view than that shown on the diagram. Of course, the carbon bisulphide method had long been known, but Mr. Broadberry had given them cogent reasons why it should not be adopted; and he could not conceive a better material for dissolving sulphur than that which Mr. Broadberry had suggested. Of course, it was only a question of economy, and Mr. Broadberry would be the first to admit that, working on an experimental plant, they could not yet attach a definite commercial value to the operation. He noticed that Mr. Broadberry estimated the saving at 0.44 cent per thousand cubic feet; but it seemed to him that to take one ton of oxide for every 2,000,000 cubic feet of gas was rather a large estimate. He did not know whether Mr. Broadberry was referring to the use of oxide alone; if he was not, he did not think he would require one ton for every 2,000,000 cubic feet of gas. With reference to the last portion of the paper, he supposed they had all experienced the difficulty arising from the amount of water in bog oxide; but there was a very simple way out of that—namely, to use, not bog oxide, but pure oxide of iron. They could get that at $7 a ton, and they could add as much water as they wanted. They had used the material very largely in the South Metropolitan Gas Company, and he very much preferred it to bog oxide. It was in an extreme state of division, and it had not the disadvantage of being mixed with clay as bog oxide was; and they could get from it far more nearly the theoretical value than from bog oxide. Then, too, when the materia got fairly charged with sulphur, instead of rejecting the whole parcel they could add, say, 5 or 10 per cent. of the powdered oxide of iron again, and the material would be as fresh as ever. He thought that was a very important advantage to be derived from the use of finely divided oxide of iron. He was sure they were all obliged to Mr. Broadberry for bringing forward this subject, which, although only a small one, was very important.

Mr. C. E. Botley (Hastings) said that sulphur had been so low in price that it was difficult to get rid of their oxide, and that they had almost to give it away. But spent oxide, contained other things besides sulphur. It contained cyanides, and for these they got about double the price Mr. Broadberry estimated as the value of the sulphur.

Mr. C. Gandon (Lower Sydenham) said that Mr. Carpenter had told them that pure oxide of iron was to be got in the market for $7 a ton. He should like to know where it was to be got at that price. He thought Mr. Carpenter was going to refer to Weldon mud, or oxide of manganese, which was not pure oxide, but which was nevertheless a very efficient material. He should like to know from Mr. Carpenter where the pure oxide was to be got at anything like the price he had mentioned, and how much moisture it contained.

Mr. Carpenter thought he had better give that information privately.

Mr. N. H. Humphrys (Salisbury) said he had just bought a consignment of natural oxide from Gloucester that contained 90 or 95 per cent. pure oxide, 2 or 3 per cent. of moisture, and the rest earthy matter.

Mr. T. May (Richmond) asked if the apparatus was patented, and if any royalty would have to be paid for its use.

Mr. Broadberry said there had been very little in the discussion to which he had to reply. Mr. Carpenter had referred to the fact that the apparatus used was only an experimental apparatus, and that the figures deduced therefrom were of little value. That he had quite admitted in his paper; and it was simply for the sake of placing the scheme before the members that he had brought forward the paper at all, when disappointed in not being able to have the full-sized apparatus. With regard to the quantity of oxide, he had estimated that one ton was used for every 2,000,000 cubic feet of gas; but that would be in gas works where oxide of iron was largely used for purification. Mr. Botley mentioned the cyanides in the spent oxide as increasing its value. That, of course, everybody knew. Oxide of iron that contained a large proportion of cyanides was more valuable than that which did not. He believed the inventors were working at a scheme for taking out the cyanides from the oxide at the same time as the cleansing operation was going on. He believed the process would leave a small proportion of lime in the oxide, but he was not acquainted with their system of taking out the cyanides. He thought the invention was patented, but he had no doubt the royalties would be included in the price of the apparatus. As to the custom of only allowing for practically half of the excess of moisture generally found in the oxide, he might add that no doubt it constituted a portion of the living profit, but while he thought the sellers were entitled to a fair profit, he did not think that was a fair way of making it. He thought it would be better to increase the price and make the profit in a direct way. If they did so, credit for the renewed oxide might be taken in his paper at a higher figure.

The Transverse Strength of Cast Iron and Its Shrinkage in Cooling.[1]

Some interesting experiments, made to determine the transverse strength of cast iron and also to illustrate the molecular changes which that metal undergoes in cooling from a liquid state, were described by Mr. W. J. Keep, M. Am. Soc. M.E., at the last meeting of the American Society of Mechanical Engineers at Detroit. These tests were made in connection with the work of the Committee of the Society on Standard Tests and Methods of Testing Materials, but were contributed as independent papers by Mr. Keep, and not as a part of the report of the committee. The main features brought out by these experiments are abstracted herewith.

Transverse Strength of Cast Iron.—Altogether 19 series of tests were made, each series consisting of 9 tests of ½ × 12 in., 3-in. and 4-in. square bars, and a 1 × 2-in. × 2-ft. bar. Series 1 to 12 and series 14 also contained two tests each of 1-ft., 4-ft. and 4½-ft. 1-in. square bars, and two tests each of 1 × 2-in. × 1-ft. bars. The bars in Series 1 to 6, inclusive, were made of "Iroquois" coke pig iron from Lake Superior ores; in Series 7 to 12, inclusive, of "Hinkle" charcoal pig from Lake Superior ore; in Series 13 to 15, inclusive, of "De Bardeleben" coke pig from Southern red fossil ore; in Series 16 to 19, inclusive, of the regular mixtures from four different foundries. These several series had their silicon varied by additions of high silicon, or silvery iron, so that the average silicon, by analysis, was for each in order as follows: Nos. 1 to 6, 0.81 per cent, 1.20 per cent., 1.88 per cent., 2.01 per cent., 3.19 per cent., and 3.04 per cent; Nos. 7 to 12, 0.93 per cent., 1.17 per cent., 1.67 per cent., 2.23 per cent., 2.71 per cent., and 3.05 per cent.; Nos. 14, 13, 15, 2.18 per cent., 3.18 per cent., and 3.51 per cent.

The iron for each of the 19 series of test bars was melted in a cupola with coke, and the molding was like that of ordinary castings, surrounded by the conditions which are certain to surround all foundry operations. All the bars for an entire series were cast from one mixture, melted and drawn from the cupola at once, and poured at the same time into molds which were of uniform composition. For this reason the larger the casting the more slowly the metal cooled. Each increase in size represents a slower rate in cooling, which caused the grain to be more coarse and loosely put together in the larger castings.

Figs. 1 and 2 show graphically the results obtained from the tests with the records of all the larger bars reduced to the dimension of a ½ inch bar 12 inches long, to enable direct comparison. The cause of much of the irregularity shown in these diagrams is the varying con-

1. *Engineering News*, Nov. 28, 1895.

ditions which surround all foundry operations. Practical iron founding cannot be separated from such influences, which produce variations in each casting. Fig. 3 is an ideal chart in which the influences which caused the variations in the record of the different sizes of bars have been eliminated, every condition being made uniform.

The following are Mr. Keep's conclusions in regard to what the tests show:

1. The strength increases in the ½-inch bars with each increase of silicon up to as high as 3.50 per cent. The castings are also softer with each increase of silicon. This corresponds with foundry experience.

2. The strength decreases as castings increase in size, when both large and small castings are made from the same iron. Decrease in strength is more rapid in castings between the sizes of ½ inch and 1 inch than between larger sizes.

3. The decrease in strength is greater and more rapid with each increase of silicon. In each of the charts the curve representing the strength due to the lowest percentage of silicon begins lowest on the ordinate of the ½-inch test bar, but owing to the decrease of strength due to each increase in size of test bar the curve ends on the ordinate of the 4-inch bar at a point much lower than that at which it began.

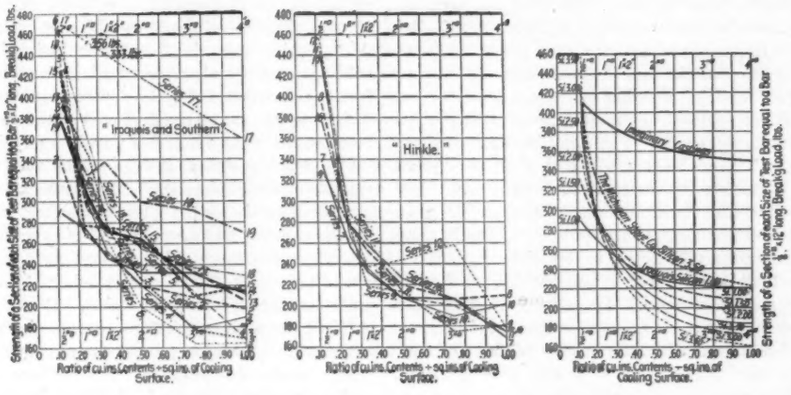
The curve representing the strength due to the highest percentage of silicon begins at the highest point on the ordinate of the ½-inch bar, and because the increase of silicon causes a more rapid decrease of strength in the larger bars, the curve drops much more rapidly than the low silicon curve. This causes the distance between the curves to diminish as the size of the bars grows larger.

That increase of silicon weakens large castings is in accord with shop experience and with general opinion. The fact that a small casting grows stronger with each increase of silicon (at least up to 3 per cent.) does not seem to have been noticed, probably because test bars of 1 square inch area have been used. It is the experience of makers of castings thicker than 1 inch that any increase of silicon softens the casting, but at the expense of strength. For large castings, therefore, it has been the practice to use the least silicon that would produce the requisite softness. It is because of variations in conditions, that cannot be avoided by the founder, that in cast iron we must allow a very large factor for safety.

4. The record of one size of test bar cannot indicate the strength of another size, for the reason that, with the same iron, aside from the local causes of derangement, any change in size—or, in other words, any change in the rate of cooling—will change the grain and strength. Each mixture of iron, and each percentage of silicon, will produce the best results in some one single size of casting, and not as good a result in any other size.

5. The term "cast iron" does not indicate a definite composition, whose strength in a test bar, broken transversely, varies directly as the square of the height, as the breadth, and inversely as the length. The metal is strong according as its grain is close and fine, and this is governed by the percentage of silicon and by the rate of cooling, and by local conditions over which the founder has no control. Therefore the test records of most investigators are of little value, because they were not aware that a large casting, cut down to another size, was weaker than if cast to size, and they were not aware that a variation in silicon would strengthen a small casting and weaken a large one. Their work would be comparable with other tests if all had recorded the percentage of silicon, or the shrinkage, which would give an idea of the amount of silicon, and if they had stated whether the casting was cast the size at which it was tested, or what size it was before it was cut down to the required size. In the latter case, however, the test would be of little value, as no casting has the same grain all the way through. The character of the original irons, also, or the heat of the cupola at the time the iron was melted, may change the strength, outside of the influence of silicon or the rate of cooling.

Some have conceived that the size of test bar which would give the most uniform results for all cast iron mixtures would be the best size for a standard. The idea would be to have the least difference between



Figs. 1 and 2.—Diagrams showing results of transverse tests of cast iron bars of different sections and lengths all reduced to size of smallest bar, ¼ x ½ x 12 inches.
(Ordinates show strength and abscissas cubic inches contents divided by square inches of cooling surface.)

Fig. 3.—Diagram showing approximate relation of strength of cast iron bars to size and percentage of silicon. All sizes being reduced to area of ¼-inch square bar.

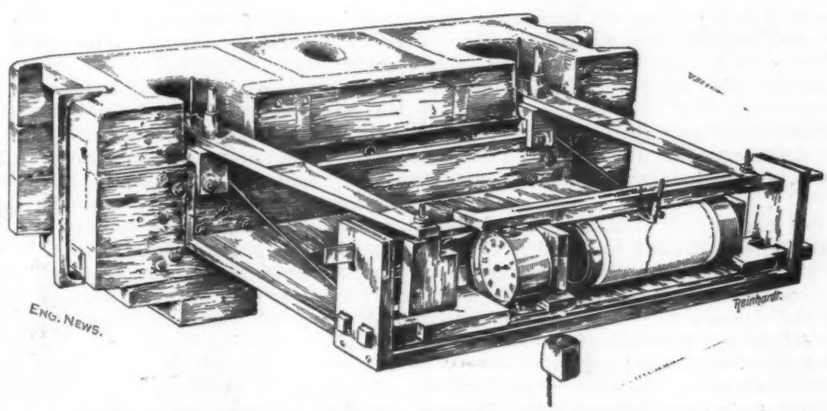


Fig. 4.—Sketch of Apparatus for Recording Autographic Cooling Curves for Cast Iron.

the highest and the lowest record and the greatest uniformity in results. An examination of Figs. 1 and 2 shows at a glance that the 1-inch bar best fills these requirements. This size shows very nearly the same record of each percentage of silicon. But as each curve crosses each of the others, there will be a size of casting which will show the same strength in both a high and a low silicon iron, and a test bar of this size would give no indication as to the difference in the metal in these irons, but the results of such a test bar would be absolutely uniform. While the 1-inch test bar gives results nearer together than any other size, yet for light or heavy machinery irons it does not give intelligible results.

The strongest iron is that which contains the amount of silicon necessary to remove brittleness in the individual size of casting, and to produce the closest possible grain. To produce the strongest castings resolves itself into methods for producing a close grain free from brittleness, (1) by using a low silicon iron for large castings, and (2) by using a higher silicon iron, which naturally has a close grain.

The first method, using low silicon pig iron, is in most common use, and the latter method requires the knowledge that a closing of the grain produces strength, and also that a pig iron with a close grain will make a close grained casting. If the founder has learned this, he is on the right track. When the principal of keeping the grain uniform and close and the iron soft has been learned, pig iron from almost any furnace can be found with a suitable grain. The mixture that produces the strongest ½-inch bar with the closest grain will also show greatest strength in a four inch casting, if the grain is kept close. Powdered ferro-manganese is often thrown into a ladle to cause a fine granular structure. Wrought iron borings or chips put into a cupola along with the pig iron will also cause the grain to be close. A rod of wrought iron is sometimes held in the spout of the cupola, so that the end may melt off and mix with the metal. An old file is sometimes melted in a ladle for the same purpose. Cast iron chips or turnings are sometimes placed in wooden boxes, with the covers nailed on, and charged along with the pig iron, to cause an even and close granular structure in the casting. The most profitable line for experiment is to find cheap practical methods for closing the grain. The grains should be of uniform sizes and of the smallest possible dimensions.

If the grain could be closed still more, we should finally obtain the result marked "imaginary casting" in Fig. 3; and if the nature of the metal could be so changed that slow cooling would not open the grain at all, but leave it the same as in the ½-inch bar, the diagram would be a horizontal line, and then, and only then, strength would vary as the square of the height, and as the breadth, and inversely as the length which would be perfection, but which can never be reached in foundry practice.

Regarding what the experiments show respecting the strength of cast iron as influenced by chemical composition, it will be seen that silicon is the controlling element, and its influence has already been explained.

It is the universal opinion that strength is mainly due to the combined carbon which the casting contains, and that weakness is caused by changing it into graphite, which mechanically separates the grains. Combined carbon weakens cast iron. In each of the charts we see that in the ½-inch bars, with each increase in silicon, the combined carbon is decreased, and that the strength is increased in the same proportion. In the half inch test bars of each series, containing about 1 per cent of silicon, the combined carbon was about 1.50 per cent., and the iron was weak because it was brittle. As combined carbon decreased in the ½-inch bars with each addition of silicon, the brittleness decreased. This is shown strikingly in Series 14, 13 and 15. The ½-inch bars show the natural strength of the iron.

Combined carbon may decrease as castings are larger, but the strength always decreases. This decrease of combined carbon and of strength are both caused by the slow cooling, and the decrease of combined carbon has nothing to do with the decrease of strength.

The general opinion is that graphitic carbon causes weakness. The carbon in a casting, so far as has been proved, is either combined or graphitic. If one decreases, the other must increase. Therefore, if combined carbon produced strength, the same facts that seemed to warrant this conclusion of the chemists seemed to prove that graphitic carbon produced weakness. Again, in graphitic iron, the grain was coarse, and the flakes of graphite lay between the grains, and it seemed self-evident that these graphitic flakes must of necessity separate the grains of iron and cut the casting up. From an examination of these series, strength or weakness seems to be absolutely independent of this element. The looseness of the grain, produced by slow cooling, so separates the grains that there seems to be more than enough room for the flakes of graphite to lie in the open spaces. It may be even doubted if the graphite ever gets between the grains to make their union less perfect. The graphitic scales seem to have formed in the spaces after the openings have been formed, and either act as a cushion, or the scales lie loosely in the cavities. This latter supposition seems plausible, from the fact that when pig iron, or a casting as large as a pig of iron, is broken, scales of graphite fall out in great abundance.

Regarding the bearing of total carbon on the question of strength, the series described in this paper do not present enough data to form any conclusions.

These 19 series bring out many interesting facts regarding sulphur. The universal opinion seems to be that sulphur is a damage to cast iron, but we can find nothing to show a ground for the origin of the opinion that prevails. Sulphur is not by any means uniform in the 19 series, but there is not the least indication of evil result from its presence in the series containing the highest sulphur.

Molecular Changes in Metals Due to Varying Temperature.—As metals shrink in proportion as they lose heat, the autographic record of such simple shrinkage should be a curve showing these proportions. Autographic records of cast iron during its cooling from a molten to a cold temperature show peculiar uniform irregularities in the curve before the shrinkage due to decreasing temperature alone takes place. This irregularity of the first part of the curve is caused by a rearrangement of the crystals, and is purely a physical process.

Fig. 4 is a sketch of the apparatus used for making the autographic records of the expansions and contractions of cast iron when cooling. A mold is made for a 1 x 1 x 26 inch test bar. In the front of the flask recesses are cut to allow the end of this mold to be reached. The top of each end of the mold is covered with a piece of tin, having a ¼-inch round hole in it, the two holes being 24½ inches apart. Through these holes are passed ¼-inch steel pins. It will be seen that when the mold is filled, the molten metal surrounds the pins, and any expansion or contraction of the bar pushes the pins apart, or draws them nearer together, as the case may be. A lever having a ¼-inch hole in its shorter arm is attached to each pin. These levers are pivoted at the edge of the flask, and the outer ends multiply any motion of the test bar ends ten times. One arm moves a slide which carries a pencil, and the other arm moves a slide upon which is located a cylinder which carries the ruled record paper, and also carries a clock which revolves the cylinder one complete revolution per hour. As one arm moves the pencil, and the other moves in an opposite direction the slide which carries the cylinder and clock; the record is the sum of the motion of the two ends of the test bar.

The curves obtained with this apparatus varied in shape with the changes in the chemical and physical combination of the iron. Iron with silicon quite high made the most attractive curve, and this curve, Fig. 5, is therefore taken as an example. This curve shows that the casting remained fluid for one minute, during which time the ends of the bar remained stationary. When the whole of the test bar had become solid it expanded for 16 minutes. This expansion began 1½ minutes after the mold was filled, increased until 3½ minutes, and then decreased until 7 minutes. This may be called the first expansion. The expansion then increased until 8 minutes, and decreased again until 10 minutes. This may be called the second expansion. A very great expansion then took place, rendering its maximum between 12½ and 14 minutes, and decreasing until 16 minutes, or a little later. This may be called the third expansion, When these expansions are completed, the regular shrinkage curve from the loss of heat is formed.

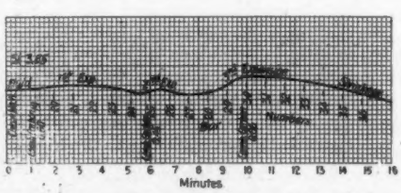


Fig. 5.—Typical Cooling Curve of Cast Iron Bars.

To get an explanation of Fig. 5, 18 test bars 1 inch square and 1 foot long were poured at the same time as the 2-foot test bar from which the diagram was taken. As the bars were made in a snap flask, there was nothing around the bar but sand. The first bar was numbered 19. At the end of 1 minute the iron in the gate was still fluid. At 1½ minutes the sand was cut away and the bar taken out, but it broke by its own weight, though it was not fluid. One half of this bar was dropped into a barrel of ice water, and the other half was allowed to cool in the air,

At the end of each minute thereafter the sand was cut away from a bar which was broken. and half of it dropped into the ice water. From the fact that the cooling of a ½-inch bar in water cannot be instantaneous, and that anything short of that would allow a change in crystallization, the quenched bars give only a faint idea of the condition of the iron at the time it was taken from the mold.

Each bar was a little stronger than the preceeding one, and as soon as it could not be broken with a pair of pincers alone, one-half of the bar was placed in a hole in a heavy block of iron, when a wrench of the pincers would break it. Then a light blow of a hammer, and toward the end quite a sharp blow from a five pound hammer was needed.

The curve in Fig. 5 was then divided according to the times of breaking the 18 bars, to see which belonged to the different parts of the curve. Previous to making the bars described, and while another curve was being made, a similiar number of bars numbered from 1 to 18 had been broken.

An examination of the fracture of these two series of quenched bars shows a great change in the crystalline structure before and after the third expansion, but these fractures do not at all show what the iron really was, because quenching cannot entirely prevent the crystals assuming their natural form. To get an approximate idea of the state of the iron, the bars numbered 19, 25 and 30 were selected for analysis; No. 19 before the iron was solid, No. 25 during the second expansion, and No. 30 just as the third expansion had reached its maximum. The combined carbon in bar No. 19 was 0.60 per cent.; in bar 25, 0.45 per cent., and in bar No. 30 it was 0.06 per cent. From the location of the curves, bars 26, 27 and 28 were probably as hard and contained as much combined carbon as No. 25. As bar 28 probably contained 0.40 per cent. combined carbon, and as bar No. 30 contained only 0.06 per cent. combined carbon, which is the same percentage as was contained by the portion of the bars which were allowed to cool in the air, it appears that the change of combined carbon into graphite takes place in less than one minute in a casting 1 inch square, cooled in its own mould, and that this is the time when hard iron changes to soft iron. After the third expansion no further change in the crystalline structure took place, and the shrinkage curve was that ordinarily made by the loss of heat. The bars Nos. 19 and 25 were so hard that they could not be touched with a drill, and it was very difficult to break off enough for analysis. It would seems that the bars were much harder than could be accounted for by the 0.60 per cent. of combined carbon, while bar No. 30 was very soft. The final arrangement of crystals took place during the third expansion, and at that time the iron became soft.

The remainder of the paper is devoted for the most part to a consideration of the different curves obtained in different tests, and which vary in form with variations in the chemical and physicial compositions of the iron. As the paper draws no very definite conclusions in this discussion as to the effect of the proportions of the various elements entering into these different compositions, we do not give the discussion here. The main point brought out is that certain molecular changes, or rearrangements of the molecules, take place during the early part of the cooling of iron castings; that apparently these take place for any particular iron at definite temperatures, and that the change of combined carbon into graphite carbon occures during the so-called third expansion. The experiments will be continued with the view of definitely establishing the full significance of the curves described.

Historical Notes of the Steam Engine.

The following interesting excerpt is from the Presidential Address of Sir Benjamin Baker, before the Institution of Civil Engineers:

When the illustrious James Watt directed his attention to the improvement of the steam engine the Seven Years War had just ended, and the country was weary of foreign and civil strife and longed for the advancement of its material prosperity. The establishment of the first iron works in Glasgow, the deepening of the Clyde in 1760, and the opening of the Bridgewater Canal, would naturally lead an original mind like Watt's to foresee some of the vast consequences of the development of manufactures and inland transport, and the hopeful spirit of the times acted as a stimulant to many other inventors. Thus, while Watt decided upon separate condensation in 1765, and patented improvements leading up to the double acting rotary beam engine in the years 1769, 1781 and 1782 respectively, we find that the years 1767, 1768, 1779 and 1784 successively saw the births of Hargreaves' spinning jenny, Arkwright's spinning machine, Crompton's mule, and Cartwright's power loom. Without these and similar improvements there would have been as little demand for Watt's engine as for Lesseps' Suez Canal before the development of steam navigation in the British marine.

It is difficult for us to realize that in the years referred to England was chiefly dependent upon her American colonies and Russia and Sweden for the supply of bar iron, and that Birmingham was popularly regarded as the center of the iron industry of Great Britain. The latter fact is illustrated by an ambitious poem of the time, entitled "Panegyric upon Iron:"

> Soon o'er thy furrowed pavement, Bremicham!
> Ride the loose bars obstrep'rous; to the sons
> Of languid sense and frame too delicate
> Harsh noise perchance, but harmony to thine.

In 1751 application was made to Parliament for the admission of bar iron duty free from our own colonies, and an act was passed authorizing this so far as the port of London was concerned, but admitting pig iron only at other ports. A clause, however, was inserted in the act prohibiting the carriage of American bar iron beyond ten miles from the city, with the acknowledged object of preventing the wagons which brought manufactured iron work from Birmingham and Walsall returning home laden with bar iron, and so furthering competition with London iron workers. There was to be no free trade, in fact, between London and Birmingham. As, however, the dearness of coals and the heavy duties thereon prevented the setting up of manufactories in London, the act was practically a dead letter, and another appeal to Parliament was made in 1755. In the petition the method of manufacturing bar iron was explained to members of Parliament in these words: "The first process is to refine the iron from the ore, and the only fuel proper for this operation is charcoal. The next process is to meliorate the iron still by means of a charcoal fire to render it malleable and draw it into bars under the strokes of a great hammer. After that the iron comes into the hands of the manufacturers, the use of wood charcoal is from thenceforth entirely laid aside, and they perform all their operations with pit coal." It was further stated that Swedish iron was charged with £3 12s. 6d. per ton export duty on leaving Sweden, and £2 8s. 6d. import duty on arriving in this country; that the Swedes had limited the production, and the Empress of Russia forbidden the erection of more iron works, and that "the present alarming connection of Russia with France should rouse us the more to turn our thoughts toward our colonies for supply."

On the very eve, therefore, of Black's discovery of the "latent heat" of steam, and Watt's practical application of the theory to the steam engine, Parliament and the public at large had not the dimmest perception of the momentous revolution which was to change Great Britain from a suppliant buyer of bar iron from abroad to the manufactory of all kinds of iron and steel for the world. Indeed, some years after Watt's first patents, Parliament was asked to grant bounties on American pig iron, but in 1783—that is to say, a year after his patent of the rotary steam engine, Sir John Dalrymple, a Scotch ironmaster, published a pamphlet in which he expressed the opinion that Watt's invention will give the command of the iron trade of the world to Great Britain, and take it forever, or at least as long as the industry and liberty of Britons remain, from the Northern Kingdoms and from America, because Britain is the only country in which seams of coal, iron ore and limestone are found in the same field, and of short water carriage to the sea. This opinion, however, was not the general one, for Watt's 20 years' work had up to that time been treated with indifference both at home and abroad. Later on the swing of the pendulum caused an error in the opposite direction, and the public attributed to Watt's foresight and genius results which we, who see things in their true perspective, know to have been the ordinary consequences of the law of demand and supply.

Up to the middle of the last century such manufactories as existed were established where water power was available, and naturally no demand existed for the more expensive steam power. At certain places where water at times ran short Smeaton and others adopted the atmospheric pumping engine to supplement the supply of water to the overshot wheels. As the population of the country increased, and commercial questions for the first time began to be regarded of paramount importance, the improvement in trades and manufactures rendered it necessary to find other sources of power than water, and when the necessity arose the engineers of the time, of course, found no difficulty in developing the hitherto neglected steam engine, just as electrical appliances of all kinds are now being developed in response to present demands.

Even now we occasionally find writers and public speakers referring to the steam engine and its momentous results as the outcome of a brilliant inspiration of Watt's transcendent genius, for which the world would have vainly waited had not Watt been born. If there is one lesson that history teaches us beyond all question, it is that when the

time comes the man is never found wanting. Watt himself never claimed to be either a scientific or mechanical genius. Writing in 1808, he said: "My soul abhors calculations, geometry, and all other abstract sciences;" and again he said, "I am not over-anxious about fame, yet I am more proud of the parallel motion than of any other mechanical contrivance I have ever made." Judging from present engineering practice, we may think that this was an unfortunate foundation for Watt to base his future fame upon, as the parallel motion is of no interest now except as a geometrical problem.

There are two points in connection with the early history of the steam engine which have always appeared to me absolutely astounding and incomprehensible; first, that any mechanic of the period, accustomed all his life to work his lathe by treadle, connecting rod and crank, should imagine that the application of the crank to a single-acting steam engine was an "invention," and actually secure a patent for the same; and secondly, that a man of Watt's ability and experience should endeavor to circumvent that patent by himself patenting that fearful "back-lashing" nightmare, the so-called "sun-and-planet" motion. It is not less remarkable that Smeaton about the same time, when reporting on a paper submitted to the Royal Society, of which he was a Member of Council, condemned the crank and flywheel because of the imagined difficulty arising from the stopping of the heavy reciprocating mass at each end of the stroke, and expressed the opinion that the use of the flywheel would be a greater incumbrance to a mill than a water wheel to be supplied with water pumped up by an engine.

There is nothing, therefore, in the history of the development of the steam engine, or in the brilliant career of Watt, to lend support to the theory that the progress of mankind is dependent upon the periodic appearance on the stage of some actor of inspired genius; but, on the contrary, many illustrations are afforded of the fact that men of the highest ability and experience are as apt to be wrong in their forecast of events and in their estimates of the relative importance of their own or other person's investigations or inventions as are those of humbler powers.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

It is announced that the Akron (O.) Gas Company has been purchased by a syndicate of which John R. Walsh, of Chicago, President of the Equitable Trust Company, is the head. The purchase price is said to have been $500,000.

The City Council of Newport, R. I., has accepted the bid of the Newport Gas Light Company to furnish 500 or more lights for a term of three years at the rate of $1.30 per 1,000 cubic feet.

City Gas Inspector Meed, of Minneapolis, Minn., in his monthly report for November, furnishes the following: The average candle power of gas furnished was 24.34; the proportion of sulphur was 19.26 grains, and that of ammonia was .64 grains per 100 cubic feet. The average maximum pressure was 2.39 inches, and the minimum 1.80 inch. From this it will be conceded that Minneapolis is receiving a very fair article in the way of illumination.

The Hasbrouck Heights (N. J.) Light, Heat and Power Company has applied for permission to lay gas mains through Carlstadt. The necessary permission will probably be granted.

The syndicate which has secured a controlling interest in the capital stock of the Norwich (Conn.) City Gas Company is composed of S. M. Young and George E. Terry, of Waterbury, Samuel Fessenden, of Stamford, Morris F. Tyler, of New Haven, Garrett A. Hobart and Edward T. Bell, of Paterson, N. J., and Henry Hayes.

A correspondent forwards the following from Hamilton, Ontario, under date of Dec. 3d: Judge Snider to-day gave his decision in the appeals of the Gas Light Company, striking off $110,000; $100,000 for the assessment of right away for the Company's pipes on the streets and $10,000 on the meters. His Honor, in his judgment, said: "The first question I have to determine is whether any of this subsoil of the streets is realty of this Company within the meaning of the assessment act. Although this question was not directly raised in the Toronto case, the Chancellor has stated his views on the point. He says he thinks the better view is to treat the mains and so much of the soil as is used therewith as a realty of the Company, and in this respect assessable. 'As to this underground soil,' he proceeds to say, 'the Gas Company is both owner and occupier.' Even if I were not bound by this portion of the judgment I should arrive at the same conclusion on the authorities therein referred to, and in the judgment of the learned Judge of the County Court of the County of York in the same matter; but I consider this limited to that portion of this underground soil exclusively occupied by the Company with its mains, that is the displaced portion and the soil immediately touching these pipes. The question then arises as to the proper valuation of this subsoil. It seems to me that, placed where it is, it has no commercial value. Its only value is as a support and protection of these pipes, and is only sufficient to give the nature of realty in these mains. Apart from the mains it is not marketable. The assessor's reasoning whereby he values it at the price of so many surface acres, including the soil under and the space above, is so manifestly wrong that no argument is required to show its fallacy. None of the Company's money is invested in it, none of its capital stock is there. It seems to me any valuation placed upon it beyond a nominal valuation would be purely arbitrary, in fact, mere conjecture. The right to break up the surface of the street to get to it when and where necessary cannot, in my opinion, form any proper element in such valuation under the assessment act. It is proved that the value of these second-hand pipes as old iron, for which alone they could be sold if apart from this 'going concern,' would be $9,300, less the cost of getting them out of the ground. Their value as part of this 'going concern' is $75,000. Now, what gives this additional value? It seems to me it is made up, at least partly, if not entirely, by the support and protection, and the right of the support and protection, of the underground soil. Without this support and protection the assessment of these old pipes would be excessive. For these reasons, in confirming the assessment of the mains for $75,000, I have exhausted the Company's whole assessable real estate in the streets. The assessment will therefore be reduced to $75,000." Judge Snider held the meters were personal property and not real estate.

An inclosure from Corning, N. Y., says that President Frank D. Kingsbury, of the Corning Gas Company, makes the announcement, through Secretary E. B. Seymour, that on and after January 1st, 1896, the price of gas will be reduced from $2 to $1.50 per 1,000 cubic feet.

An interruption to the gas supply at Danielson, Conn., occurred a few nights ago, caused by a fire at the works of the Gas Company, which practically destroyed one end of the plant and left the town in darkness.

The Columbus (O.) Gas Company has just paid its employees their first dividend under the profit-sharing arrangement recently adopted by the Company. The men receive the same per cent. dividend as do the stockholders, it being based, however, upon the salaries and wages paid.

At a meeting of the Board of Supervisors of Poughkeepsie, N. Y., held December 4th, it was decided to accept the offer of the Poughkeepsie gas works to light the jail and court house at the rate of $1.75 per 1,000 cubic feet, the total amount for said service not to exceed $650 for the year. This is an advance of $184 over the amount paid to the Gas Company last year for the same service, but was made necessary by the excessive consumption of gas in the jail building, above the normal, and which resulted eventually in a loss to the Company.

The annual meeting of the Carondelet (Mo.) Gas Light Company was held on the morning of December 2d, and resulted in the re-election of the three following Directors, who will serve two years: Messrs. Charles Green, I. H. Lionberger and James Campbell. The hold-over Directors, whose terms expire next November, are Judge G. A. Madill, John Scullin, Henry C. Scott and Alexander C. Ross. Manager Taylor Stith has made the official announcement that, commencing January 1st, 1896, the price of illuminating gas in Carondelet will be reduced from $1.25 to $1.10 per 1,000 feet, and gas for fuel from $1 to 90 cents per 1,000. These prices will be subject to the usual discount of 10 per cent., making the net cost $1 and 80 cents respectively for illuminating and fuel gas.

Gov. Altgeld, of Illinois, during an address before the Board of Trade at Chicago recently, had the following to say touching matters gaseous: "In Massachusetts they have a State Board which has the power to fix the price of gas in every city in the State. It is required to make an examination of the value of the plant, the cost of making gas and the various facts that should be considered, and it then fixes a price for gas which shall produce simply a fair income on the investment and conduct of the business. This is intended as a protection of the public. On the other hand, the law aims to protect the company against blackmail by city councils, and provides that no new company shall be

chartered to go into the gas business unless, in the judgment of the board, the public interests require it. The effect of this law, as I understand it, has been to furnish gas at reasonable prices to the people of Massachusetts on the one hand and to relieve the gas companies of the limitless expense incident to the blackmailing operations of local officials, so that as a result gas properties are no longer speculative in their nature, but are treated as a good investment, and being freed from such unnecessary expense companies are able to furnish cheaper gas. I wish to say that the era of competition seems to be drawing to a close in our country and that governmental regulation, weak as it may be, seems to be the only practicable remedy or protector of the public that is yet visible." This is a reasonable estimate of the effects of the Massachusetts policy, and coming from so radical a person as Mr. Altgeld, it ought to be a warning to that class which would plunge the State into public ownership of lighting and similar industries.

THE Derby (Pa.) Gas Company has been absorbed by the Delaware County Gas Manufacturing Company. The new Company intends to extend its mains to the boroughs of Sharon Hill, Collingdale, Colwyn, Yeadon, Clifton and Lansdowne, for all of which it has charters, and the price of gas for lighting purposes will be $1.25, and for manufacturing and heating, 70 cents per 1,000 cubic feet.

THAT the Citizens Electric Light Company, of Salt Lake City, Utah, is in desperate straits as regards its hold on existence, will be seen from the circular recently sent out by said Company, a synopsis of which reads as follows: "The Citizens Electric Light Company announces to its patrons the following schedule of prices for the month of November: Arc lights, 10 o'clock service, $1.50 per month; 12 o'clock service, $2 per month; all night service, $2.50 per month. Incandescent lights (16-candle power), 10 o'clock service, 20c. each per month; 12 o'clock service, 30c.; all night service, 40c. Residence lights (16-candle power incandescent), 15c. each per month. These prices apply to all consumers, regardless of contract rates. All burned-out lights exchanged gratis as heretofore." These rates are a cut of about 75 per cent. when compared with the rates in force before the competition of the Citizens Company started the slashing of rates. The monthly bills now being made out will all be figured on that basis, regardless of the contract rates. The residence rate is figured flat at 15c. because of a lack of meters, but a low rate is promised under the reign of meters. This is the first strongly aggressive move of the Citizens Company in the matter of rate slashing. It probably means a war of extermination. A fight is also about to be inaugurated over the municipal work. The contract with the old Company will expire on March 1st next, and an effort will be made to secure the renewal of the contract for the Citizens Company. In order to do this it will be necessary to give the new Company time to set its poles and make its connections, and the proposition now is to have the Council, as soon as the new one is organized, ask for bids for the lighting and settle upon the favorable Company in time to admit of a setting of poles. It is argued that if this cannot be done the approach of the expiration of the contract will find the city at the mercy of the old Company. At the above rates it would be a wise move for the city to make a long term contract with the Citizens Company, and Supt. Kempf, of the Gas and Electric Light Company, would undoubtedly prefer that the Citizens Company got the plum.

THE San Francisco (Cal.) *Call*, under date of November 27th, has the following to say regarding the San Francisco Gas Light Company:

There is soon to be more competition in electric lighting in San Francisco. The new competitor of the four Companies now in the field—the California Electric Light Company, the Edison Light and Power Company, the Sacramento Electric Light and Power Company, and the Virginia and Gold Hill Electric Light Company—is the San Francisco Gas Light Company, which in a sense is a competitor at the present time. But the Company intends to establish a large electric plant in conjunction with its gas works, and enter directly into competition for electric business. Just how extensive the new plant will be, where it will be located, and the general details of the new enterprise, have not as yet been decided upon, but it is a settled fact that the plant will be established, and the plans as thus far developed contemplate the beginning of operations in a very short time. The system, it is understood, will be the Siemens-Halske, in fact, O. S. Lyford, of Chicago, the engineer of that Company, is in the city negotiating with the Gas Light Company for the adoption of the system. J. B. Crockett, President of the Gas Light Company, when seen last evening relative to the report that his Company was about to branch out in the lighting business, said it was too early to give any details of the Company's plans, that they were not fully enough developed as yet, but admitted it was the intention of the Company to establish an electric plant. He said: "I can't tell you how extensive the plant will be or where it will be located. We have not come to that yet; but we are in the lighting business and want to be in it for all it is worth. We have decided, therefore, to put in an electric plant, and it will be large enough to furnish light for the entire city. Mr. Lyford, of the Siemens-Halske system, is here figuring with us on the matter, and it will probably be that system we will use. I can give you nothing further that is definite until he has finished making his estimates and I have submitted his proposition to our Company."

ISABEL KIRCHHOFFER, daughter of Mr. and Mrs. John Maybury Young, was united in marriage to Mr. Albion Lambert Page, at the home of the bride's parents, "Ingleside," Madison, N. J., on the afternoon of December 11th. The groom is a worthy son of the late George Shepard Page, and his many friends in the fraternity will join with us in hearty congratulations over the happy achievement of his heart's desire.

THE Berlin Iron Bridge Company, of East Berlin, Conn., has just completed for the United States Projectile Company, at South Brooklyn, N. Y., the steel framework for a new annealing room. The building is 100 feet wide and 150 feet long, and is designed to be a fireproof structure.

WITH consolidation in Brooklyn an accomplished fact, and having also in mind the provisions of the Wray bill affecting gas contracts, the following from the *Eagle* of the 9th inst. is interesting and significant:

The Board of Aldermen met at 2:10 this afternoon. Alderman J. Walkeley, Chairman of the Committee on Gas and Electricity, said that there would be no report to-day from that committee in reference to bids and contracts for street lighting by gas. Last week the committee or a majority of them agreed to report in favor of bids and contracts for five years with a sliding scale of prices. A report was prepared, and it was understood that it would be signed by Aldermen Walkeley, Volmer and Leich. To-day Ald. Leich refused to sign the report. He said that as the Mayor had intimated an intention to veto such a proposition, he did not care to vote for the measure, as its adoption might make political capital at the expense of the Board. Mr. Leich also said that the report as now prepared is not the same as that which was agreed to last week. Mr. Walkeley was asked if this was true. He replied that the report was exactly the same as the one which Mr. Leich had agreed to vote for at the last meeting of the committee. Mr. Leich, when spoken to by Ald. Volmer, said that the matter should now be dropped. The Board was being pounded for proposing it. Volmer said he did not care for that. The following was read:

To the Honorable, the Common Council of the City of Brooklyn: The Mutual Gas and Electric Company, a corporation duly organized and existing under the transportation corporation law of the State of New York, calls the attention of your honorable body to its application, submitted some months ago to your honorable body, for the municipal consent to lay conductors for conducting gas through the streets, etc., of the city of Brooklyn, under such regulations as may be prescribed, and to the offer in such application contained that in the event of receiving the consent of your honorable body, as aforesaid, it, the said Company, its successors or assigns, should and would at all times of operating under the said consent for the manufacturing and supplying of gas to the said city, furnish and sell gas to the full extent of its plant, at and after the rate of $1 for each 1,000 cubic feet, and also to the offer therein contained to pay to the said city of Brooklyn for such consent the sum of $2,000 per annum. The Mutual Gas and Electric Company is informed that it is the intention of your honorable body to make a contract for five years to come with the new gas trust or consolidation known as the Brooklyn Union Gas Company, to supply gas to the municipality for the lighting of its streets and highways, at and after the rate of $1.25 per 1,000 cubic feet, for the said term of five years. The Mutual Gas and Electric Company believes this to be a wasteful expenditure of money, in view of the fact that it had already offered to supply gas, not only to the city of Brooklyn, but to all persons who may wish to apply for the same, at and after the rate of $1 per 1,000 cubic feet. The Mutual Gas and Electric Company hereby offers to supply gas to the city of Brooklyn, if granted the municipal consent heretofore prayed by it, at and after the following rates, that is to say: $1 per 1,000 cubic feet for the first year; 90 cents per 1,000 cubic feet for the second year; 85 cents per 1,000 cubic feet for the third year; 80 cents per 1,000 cubic feet for the next two years. The Mutual Gas and Electric Company respectfully remonstrates against the making of any contract for so long a period as five years at so high a rate, while so much better terms can be secured for the benefit, not only of the taxpayers, but of the public in general. The Mutual Gas and Electric Company is ready forthwith to proceed with the construction of its plant, and the supplying of gas upon receiving the necessary consent of your honorable body, and to supply gas to the city of Brooklyn at the prices aforesaid, and to enter into a contract accordingly.—Dated Brooklyn, December 9, 1895.—THE MUTUAL GAS AND ELECTRIC COMPANY.

THE AMERICAN GAS LIGHT JOURNAL

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MONDAY, DECEMBER 16, 1895.

How Mineral Wool is Made.

Of those who know what mineral wool is, or silicate cotton, as it is sometimes called, probably only a small number are familiar with the simple process by which it is made. The wool itself, serving a variety of useful purposes, as a non-conducting covering against heat and cold alike, for steam pipes and cold storage room walls, as a sound "deadener" in floors of buildings and as a means of fireproofing, among many others, is, as its name implies, a soft and wooly substance, consisting of a mass of very fine mineral fibers interlacing one another in every direction, and thus forming an endless number of minute air cells. The wool appears on the market in a variety of colors, principally white, but often yellow or gray, and occasionally quite dark, and is made by converting scorial and certain rocks while in a molten state into a fibrous condition by a steam blast directed against the liquid material. Blast furnace slag forms the raw material for one variety of the wool, and sandstone for another, yielding, respectively, slag wool and rock wool, the latter being preferable for pipe covering because of the absence from it of sulphur, which, with moisture present, becomes an active corroding agent. The furnace slag or the rock, as the case may be, is melted in a large cupola, and as it trickles out at the taphole in a somewhat sluggish stream, it meets a high pressure steam jet which atomizes the woolen material, if it may be so termed, blowing it in fleecy clouds into the storage room provided for it. Soft and downy, the stuff settles wherever a resting place affords itself, the heavier and easier wool coming down first, while the lighter portions are blown further along by the force of the steam and settle in the more distant parts of the room, the material thus naturally grading itself into varieties of different quality. A thousand pounds of wool per hour are turned out by one of the cupolas, and after the storage room has been blown full the flocculent mass is pushed into bags, ready for the market. The whole process affords an admirable and interesting illustration of the utilization of an utterly waste product.

The Danger of Brief Neglect.

Some years ago experiments were carried on at Sandy Hook with steam boilers, under various conditions, says the *Safety Valve*, and among them was a case in which a boiler was exploded deliberately and experimentally by over-pressure; but the manner in which the application of different pressures was made, and the results thereof, teach a rather startling lesson in the line of what might happen under careless management. An old steamboat boiler had been removed and finally turned over to the experimenters for the good of the engineering profession. The boiler had been, when last in use, tested by hydrostatic pressure up to 59 pounds, and had been allowed by the steam boiler inspectors of the district to carry a working pressure of 30 pounds, and, soon after being removed, was subjected to an experiment which resulted in a violent explosion, completely demolishing the boiler.

The records commence with a steam pressure of 29½ pounds, and in 13 minutes the boiler exploded with terrific violence at a pressure of 43½ pounds, or 5½ below the hydrostatic test pressure. The rise of steam pressure during the experiment was fairly uniform, and when 50 pounds was reached some of the stay bolts parted in the welds, the crowfeet remaining in place. Then, a few minutes later, quite contrary to the accepted belief as to old boilers gradually giving out with little or no violence, the entire boiler exploded like an immense bombshell, leaving nothing at the location but a mass of mutilated tubes. If that boiler had been in useful service and subject to neglect at various times, with the pressure going to no one knows where, at some time or other, a few minutes' absence of the fireman or engineer, coupled with an overloaded safety valve, would have caused the most destructive sort of a boiler explosion, with the usual mysterious accompaniments.

Aristol.

Aristol is a coal tar product and is of special utility for the treatment of burns. It is at once an anaesthetic and kills pain; an antiseptic, and keeps the burn sweet; a gentle stimulant, and promotes granulation and healing; and, unlike iodoform, it produces no poisonous effects whatever on the system. When the burn occurs it should be at once thoroughly washed, and thereby disinfected, with a 2 per cent. solution of boracic acid (not borax), and all the visible blisters punctured with a fine needle. Round this is applied, on muslin, a salve made up thus: Aristol 1 to 2 avoirdupois ounces, olive oil 2 ounces by weight; dissolve and mix with 4 oz. vaseline and 4 oz. lanoline, all worked up together with a flexible knife on a smooth slab. This mixture, as well as the boracic acid solution, should be kept on hand, ready for immediate use. Round the muslin is put a thickness of sterilized cotton wool, and round this a layer of gutta-percha tissue, and round all a bandage. Even when the burn is due to hot chemicals, the pain goes down almost at once, and the healing begins very promptly.

Gas Engines for Raising Water.

In Germany the first application of gas motors to raising water was made at Duren, near Aachen, in 1884, and in the same year a steam engine was replaced by a gas motor for the same purpose at Quedlinburg. In 1886 Rattwill and Coblenz, in 1887 Furth and Peine, and in 1888 Karlsruhe and Munster followed suit; and these installations are still working with excellent results. According to a recent report of the Quedlinburg Gas and Water Company, the saving in the cost of pumping with gas engines, as compared with steam, taking the last year in which steam was used and the second with gas, was 42 per cent.

While the gas motor occupies less space than the steam engine with its boiler and chimney, it has the advantage as regards attendance, for one man can look after several gas engines, while a steam engine plant of any importance requires an engineman and stoker, and often an additional hand to keep up the coal supply. Another advantage of the gas motor is the fact that it can at any time be put to work immediately, so that considerable water pressure may be made available in a few minutes, which is very important in case of fire, while the dimensions of reservoirs may be reduced if the motors be kept constantly running.

The Market for Gas Securities.

The feature of the week in city gas shares was the great all around advance made in Mutual, Equitable and Consolidated, as also the hardening in New York and East River. To-day (Friday) Mutual is bid for at 255, 63 shares having been sold at auction, on Dec. 11, at 255¼; Equitable shows at 224 bid, asked 230, and Consolidated sold up to 161. Standard is the only local stock that has not made a marked advance over prices of a week ago, 24 shares common of which sold at auction on Wednesday for 70¼, and 20 shares preferred at 107¼. This all goes to show that an amicable understanding exists between the several gas interests in this city, and is but the beginning of the end that ultimately will find New York's gas supply united under a mutual direction.

The prediction made in the JOURNAL as long ago as six months, that Consolidated gas, of New York, would go to 160 before Christmas, has already been verified. For investment account it is none too high at ruling figures.

Chicago gas is a purchase at present prices, namely, 68⅛ bid, and should shortly go to 75. It may be said in this connection that the Chicago Gas Companies will be allowed to unite under a legal trust form, notwithstanding the various injunctions asked for to interfere therewith. The stock is in strong hands, and of the earning ability of the Companies composing the trust there can be no reasonable doubt.

Brooklyn Union gas is bid for at 87, asked, 87¼, and the Company informs holders of the first mortgage bonds of the Williamsburgh, Peoples, Metropolitan and Fulton-Municipal Gas Companies, that the holders of consolidated first mortgage bonds of the Citizens and the Union Gas Light Company, which last must first be exchanged for the consolidated bonds of the Citizens Company, that it is now prepared to issue for these various issues in its own

first consolidated mortgage 50-year 5 per cent. bonds, on the basis of bond for bond, with interest adjusted to date of the exchange. The exchanges will be made by the New York Guarantee and Indemnity Company.

Laclede common shows a slight decline to 23—23¼, while preferred has advanced to 84—85¼. The Directors of the Welsbach Light Company, on Dec. 11, declared a dividend of 20 per cent., payable Dec. 23, to stockholders of record at close of business Dec. 14. Cincinnati gas sold at 203¼.

Gas Stocks.

Quotations by Cochran & Close, Brokers and Dealers in Gas Stocks.

35 Wall St., New York City.

December 16.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$35,430,000	100	161	..
Central	500,000	50	150	..
" Scrip	220,000	..	100	.
Equitable	4,000,000	100	224	230
Bonds, 6's	1,000,000	1,000	106	..
" 1st Con. 5's	2,300,000	1,000	114	.
Metropolitan Bonds	658,000	..	108	112
Mutual	3,500,000	100	255	..
" Bonds	1,500,000	1,000	100	102
Municipal Bonds	750,000	..	..	.
Northern	150,000	50	79	80½
" Bonds	150,000	1,000	..	98
New York and East River	5,000,000	100	36½	36⅝
Preferred	2,000,000	100	66⅛	69
Bonds 1st 5's	3,500,000	1,000	101¼	102¾
" 1st Con. 5's	1,500,000	..	88¾	89¾
Richmond Co., S. I.	348,650	50	50	..
" Bonds	100,000	1,000	..	..
Standard	5,000,000	100	70	71½
Preferred	5,000,000	100	106	109
Bonds, 1st Mortgage, 5's	1,500,000	1,000	109	110
Yonkers	299,650	50	112	..
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	140	..
Citizens	1,200,000	20	70	..
" S. F. Bonds	320,000	1,000	..	101
Equity	2,000,000	10	..	..
" Bonds	1,000,000	..	..	..
Fulton-Municipal	3,000,000	100	220	..
" Bonds	300,000	..	108	..
Peoples	1,000,000	10	100	.
" Bonds, 7's	368,000	..	100	..
" " 6's	94,000	..	98	100
Metropolitan	870,000	100	200	..
" Bonds, 5's	70,000	..	..	..
Nassau	1,000,000	25	310	..
" Ctfs	700,000	1,000	99	100
Williamsburgh	1,000,000	50	310	..
" Bonds	1,000,000	..	107	110
Out-of-Town Companies.				
Bay State	5,000,000	50	20	22
" Income Bonds	2,000,000	1,000	..	80
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	78	80
2d " " "	3,000,000	1,000	54	56
Buffalo Mutual	750,000	100	125	..
" Bonds	200,000	1,000	95	100
Central, San Francisco	2,000,000	..	95	..
Chicago Gas Co.	25,000,000	100	..	6⅝
Chicago Gas Lt. & Coke Co. Guaranteed Gold Bonds	7,650,000	1,000	94	94¼
Columbus	1,069,000	..	66½	67
1st Mortgage	1,085,000	..	94	95
Consumers. Jersey City	2,000,000	100	..	88
" Bonds	600,000	1,000	100	103½
Cincinnati G. & C. Co.	7,000,000	100	203¾	..
Consumers, Toronto	1,600,000	50	184½	187
Capital, Sacramento	500,000	50	..	41
Bonds (6's)	150,000	..	..	..
Consolidated, Baltimore	11,000,000	100	60½	61
Mortgage, 6's	3,600,000	..	107	107½
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490,000	..	..	..
Detroit	4,000,000	..	29½	30¾
" Con. Bonds	4,312,000	..	71½	75
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Fort Wayne	2,000,000	..	76½	78½
" Bonds	2,000,000	..	89	91
Hartford	750,000	25	130	135
Indianapolis	2,000,000	..	142	147
" Bonds, 6's	2,650,000	..	103	105
Jersey City	750,000	20	180	..
Lafayette Gas Co., Ind.	1,000,000	100	85	85
Bonds	1,000,000	1,000	85	87
Louisville	2,570,000	50	..	130
Laclede, St. Louis	7,500,000	100	23	23¼
Preferred	2,500,000	100	84	85½
Bonds	9,084,400	1,000	96½	97
Little Falls, N. Y.	50,000	100	..	100
Bonds	25,000	..	..	100
Montreal, Canada	2,000,000	100	200	..
Newark, N. J., Gas Co.	1,000,000	..	75	.
Bonds, 6's	4,000,000	..	120	..
New Haven	1,000,000	25	225	..
Oakland, Cal.	2,000,000	..	46½	..
" Bonds	750,000	..	..	..
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	2,100,000	1,000	..	108
2d "	2,500,000	1,000	104	105
Peoples, Jersey City	500,000	50	..	175
Paterson, N. J.	.....	25	99	102
Rochester Gas & Elec. Co.	2,150,000	50	..	..
Preferred	2,150,000	50	88	..
Consolidated 5's	2,000,000	..	87½	90
San Francisco, Cal.	10,000,000	100	71½	72
St. Paul Gas Light Co.	1,500,000	100	68½	70
1st Mortgage, 6's	650,000	..	88	90
Extension, 6's	600,000	..	..	..
General Mortgage, 5's	2,400,000	..	88	90
Syracuse, N. Y.	500,000	25	..	..
Washington, D. C.	2,000,000	20	250	..
Western, Milwaukee	4,000,000	100	68	70
Bonds, 5's	3,556,000	..	93	94½
Wilmington, Del.	500,000	50	186	190

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ELECTRICAL APPARATUS.

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DIVIDEND NOTICE.

OFFICE OF WELSBACH LIGHT CO.,
DREXEL BUILDING, PHILA., Dec. 11, 1895.

The Directors have this day declared a dividend of twenty (20) per cent., payable on Dec. 23, 1895, to stockholders of record at the close of business Dec. 14. Checks will be mailed. EDWARD C. LEE, Treasurer.

WANTED,

A Second-Hand Station Meter,

54 inches in diameter, 8 inch connections. Must be in good order. Address,

CENTRALIA LIGHT & POWER CO.,
1071-2 Centralia, Ills.

POSITION WANTED

As Supt. or Manager of a Gas Works or Gas and Electric Light Works.

Fifteen years' experience as Manager of Gas Works and six years Gas and Electric Light Works. Good reasons for wishing to change present employment.
1048-tf Address "Y. B.," care this Journal.

WANTED,

By a man who has had a round experience in the manufacture and sale of gas,

A Position as Supt. of a Large or Small Gas Works.

Is capable and energetic, and is willing to begin at a moderate salary. Address
1032-tf "B.," care this Journal.

GAS WORKS.

WANTED TO PURCHASE, whole or controlling interest in small Gas Company not having electric light attachment. Must be in New England, New York, New Jersey or Pennsylvania. Give particulars as to indebtedness outside of capital stock, selling price, population and kind of gas made. All communications will be treated as confidential. Address "INVESTMENT," care this Journal.

Proposals for Coal Tar.

The North Adams (Mass.) Gas Light Company invites Proposals for its annual output of Gas Tar, amounting to 600 barrels. The gas made on these works is strictly produced from the carbonization of the best gas coal, no oil being used even for enriching purposes.
1064-tf F. S. RICHARDSON, Treasurer.

FOR SALE,

One No. 7 Gas Exhauster, Wilbraham-Baker Blower Company's Make.

Capacity, about 70,000 ft. per hour. The Exhauster is complete, with Governor and Engine all on bedplate; is in good condition (almost as good as new); was not used much; replaced by a larger machine of same make. Apply to the undersigned, care of Pittsburgh Gas Co., 435 Sixth Avenue, Pittsburgh, Pa. JOHN H. McELROY,
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Four Purifying Boxes, 8 ft. by 8 ft.,

with 6-inch Center Valves and Connections, in good order.

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Gas and Electric Plant in Substantial, Growing Kansas Town of 5,000 People.

No bonds nor debts outstanding. It is a money maker. Present owners wish to retire from business. Will sell whole or half interest. $10,000 will secure half interest and the superintendency, at $75 per month. Address
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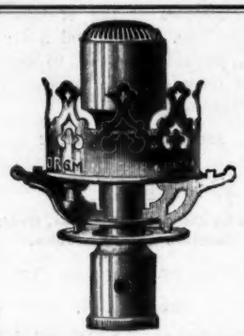

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Manufactured in only the Highest Grades marketable.

MARTIN GÜLZOW, 26 Suydelstrasse **Berlin, C.**

WANTED,

A General Agent for Fixed Sales.

Utilize Your Gas Liquor.

NO EXTRA LABOR OR OPERATING EXPENSES.

Ammonia Concentrator,

Not Expensive. Write to STROH & OBIUS, Pat'ees, or Mich. Ammonia Works. Detroit, Mich.

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ALL SIZES AND SHAPES.

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NO INFRINGEMENT OF THE AUER PATENTS TO BE SUBSTANTIATED.

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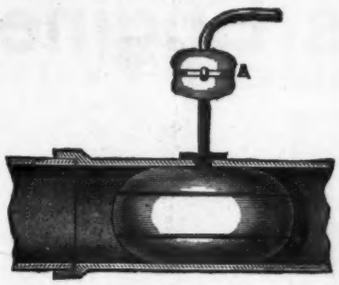
Peerless Patent Improved Gas Bag



These Gas Bags are used to stop the flow of gas while repairing or making alterations in gas mains. There have been numerous cases of workmen being badly injured, and sometimes fatally, by the escape of gas resulting from the bursting of a bag, and our patent improvement is designed to obviate such calamities. The indicator *A* shows unerringly when the bag has been sufficiently inflated to pack the main, and when the pumping should be stopped. Our Bags are made of a rubber stock especially prepared to admit of great distension, and to resist the action of Oils, Gases, Naphtha and other residuum in the mains, and they are made with lapped joints, which adds greatly to their strength.

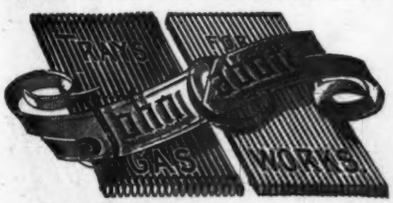
3-in.	Gas Bag,	each,	$0.60	12-in.	Gas Bag,	each,	$5.00
4	"	"	.80	16	"	"	8.25
5	"	"	1.05	20	"	"	12.00
6	"	"	1.75	24	"	"	17.00
8	"	"	2.65	30	"	"	27.50
10	"	"	3.75				

The Peerless Rubber Mfg. Co.
16 Warren St., N. Y. City.

Special Trays for Iron Sponge or Oxide of Iron.

CHURCH'S TRAYS a Specialty.

Reversible, Strongest, Most Durable, Most Easily Repaired.



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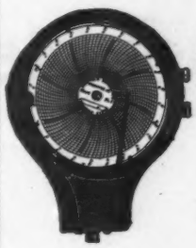

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Simple in Construction,
Accurate in Operation,
Low in Price,
Fully Guaranteed.
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THE BRISTOL CO.
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Received Medal at World's Columbian Exposition.

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SOLE IMPORTER OF THE CELEBRATED
German (Stettin-Didier) Clay Gas Retorts,
BLOCKS, TILES, FIREBRICKS, FIRE CEMENT,
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10 & 12 Old Slip, New York.

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NEW YORK GAS TUBING CO.
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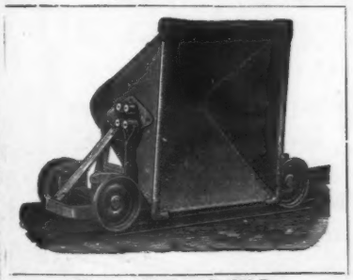

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INDUSTRIAL RAILWAYS
Specially designed for handling material in and around
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Has been made by
WILDER'S VOLUMETRIC GOVERNORS.
They control the pressure at the burner, and deliver the quantity for which they are set regardless of high or low pressure in the supply.
WELSBACH LIGHTS are fully controlled, and the governors soon pay for themselves by preventing the breaking of mantles and chimneys. Thousands are already in use. Orders may be given to the Welsbach Co., or sent to ourselves.
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CORRESPONDENCE SOLICITED.

Is Mined and Shipped from the Best Gas Coal Basin in Pennsylvania.

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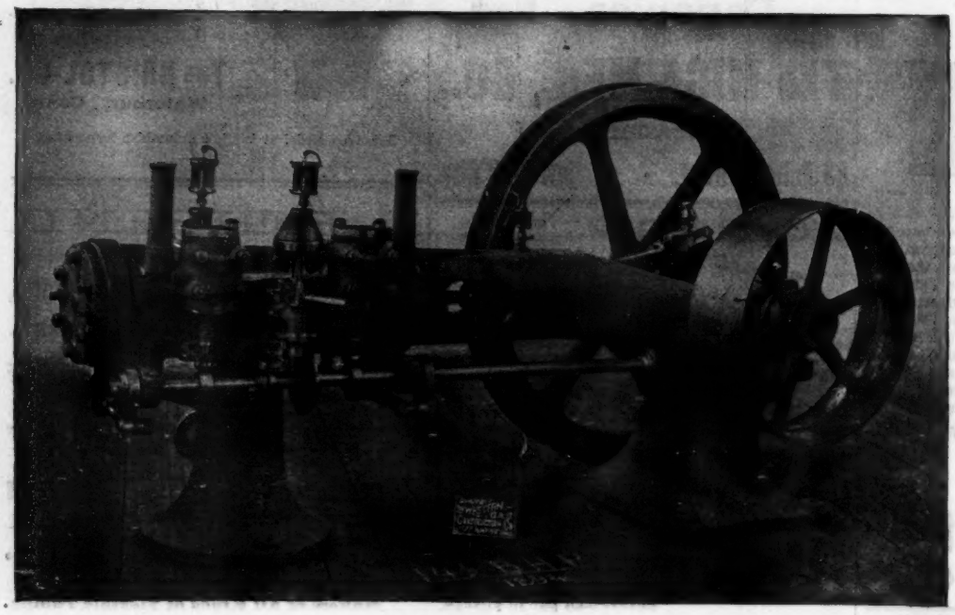
THE AMERICAN GAS ENGINE CO.,

MANUFACTURERS OF

The Double-Acting Gas Engine,

Under the Patents of Griffin, and Dick, Kerr & Co., of London and Kilmarnock.



Single Cylinder.

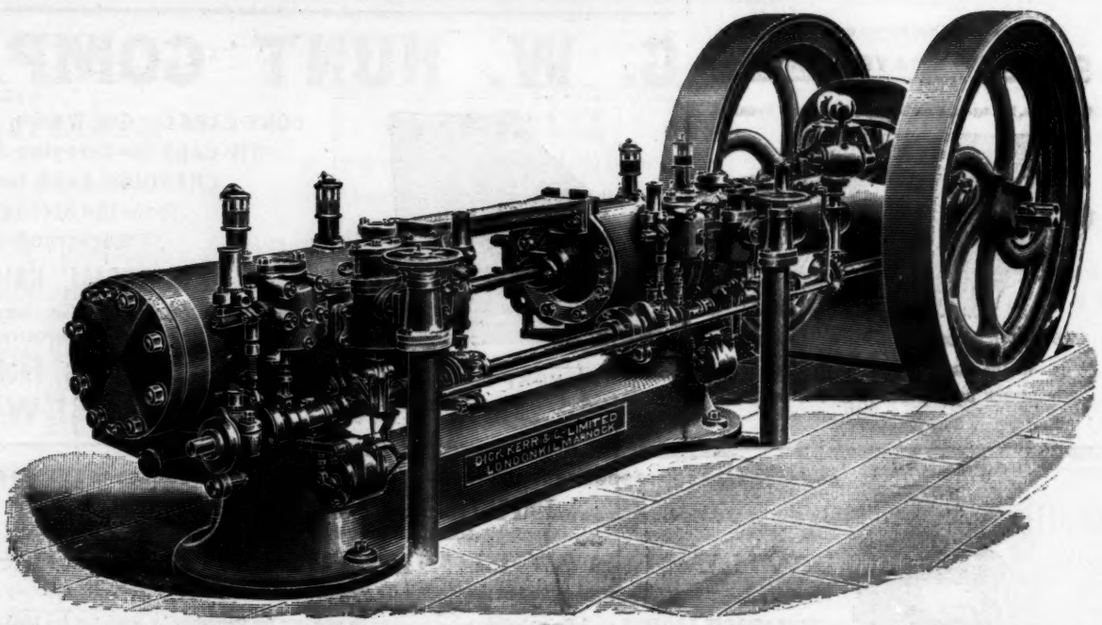
Impulse Every Revolution.

(Two Strokes.)

15 to 500 Horse Power.

For General Work and Isolated Electric Plants.

Tandem Cylinder. Impulse Every Stroke. 100 to 1,000 Horse Power. For Central Stations and all work requiring extreme steadiness.



ESSENTIAL PRINCIPLE.—An impulse at each end of piston; using half force to each impulse; doubling the steadiness; reducing the wear on moving parts, and weight for given power. **CONSTRUCTION.**—The piston rod works through stuffing box in front end of cylinder, and connecting rod is carried in a cross-head working in a slide in frame, as in ordinary steam engine practice. All valves are of the poppet type, operated by cams on a single cam-shaft, giving positive movement to every working part. Tube or electric ignition. **RESULT.**—An engine of extreme simplicity and steadiness of action, the even wear on the cylinder and all working parts assuring increased economy, long life, and minimum cost in repairs. **RECORD.**—Successful and constant use in Great Britain for the past eight years. Address

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The Improved

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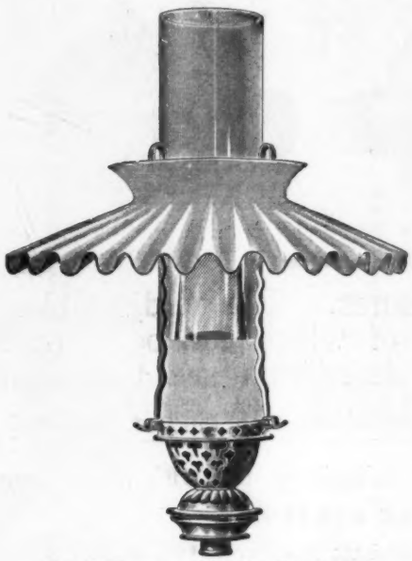

No. 31 Burner, with No. 74 Shade.

No. 31 Burner, with Nos. 10 and 43 Shades.

Made by the

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Sole Manufacturers for the United States.

The WOLFF Gas Radiator.

Size, 33 Inches High, 21 Inches Wide and 10 Inches Deep. The Trilby Heaters are furnished in Brass, Copper-Bronze and Nickel Plate.

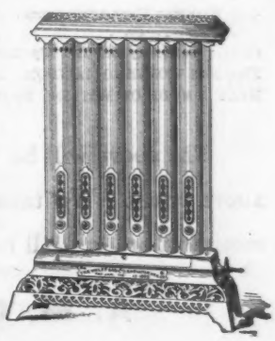
The Most Ornamental and Economical Gas Heater in the World.

The WOLFF Gas Radiators are no Longer an Experiment.

Heating with gas as a fuel instead of wood or coal was made practicable only four years ago, when the first WOLFF Gas Radiator was made. Since that time we have supplied Gas Radiators to heat all kinds of Rooms, Halls, Stores, Churches, Theaters, etc.; they are used in Bed Chambers, Sick Rooms, and wherever heat is required. And, because of their great success, several imitation Gas Radiators are offered, "said to be as good as Wolff's;" but none of them are as good. The WOLFF Radiator gives more and better quality of heat, at less cost, than any gas heater in the market.

In our Trilby Heater we again offer something **new, novel** and **good,** as well as beautiful and pleasing to the eye. Most Stoves, Heaters and Radiators in use heat the **top** of the room, leaving the **floor** cold (hence keep the head warm and the feet cold). Our Trilby Heater warms the floor first; then the heat rises gradually, warming the whole room comfortably, cold air being drawn in from the bottom (passing between the heated radiating flues) and thoroughly warmed before passing out at the top, while the gas, mixed with air, is burned in our "Patent Incandescent Iron Fires Burners," which greatly intensifies the heat, causing an extra amount of heat to be radiated, or thrown off onto the floor, while the products of combustion are carried up through radiating iron flues to the top of the Trilby Heater, and downwards and out through opening to flue or chimney pipe connection, making a current or outlet for burnt gas or impure air, thus causing perfect ventilation in the room.

The Trilby uses less gas and gives more and better heat than any other Gas Radiator in the market.



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THE WOLFF GAS RADIATOR MANUFACTURING CO.,

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Bray's Patent "Enamel" Gas Burners.

Bray's "Special" and "Adjustable" Burners

Are the Cheapest, Most Economical and Most Durable in existence, and will, at their REDUCED PRICE, save their cost in gas alone in forty hours' use.

Union Jet. Slit Union. Batswing. Adjustable.

The "Specials" are made to Suit Low and High Pressures. The "Adjustables" consist of two Burners screwed together, the sizes of which can be arranged to suit any Pressure and Consumption. For full description see Catalogue.

See that **"Bray's Special"** or **"Bray's Adjustable"** is stamped on each kind of Burner.

ACETYLENE AND RICH OIL GASES.—We now make Burners suitable for use with these Gases.

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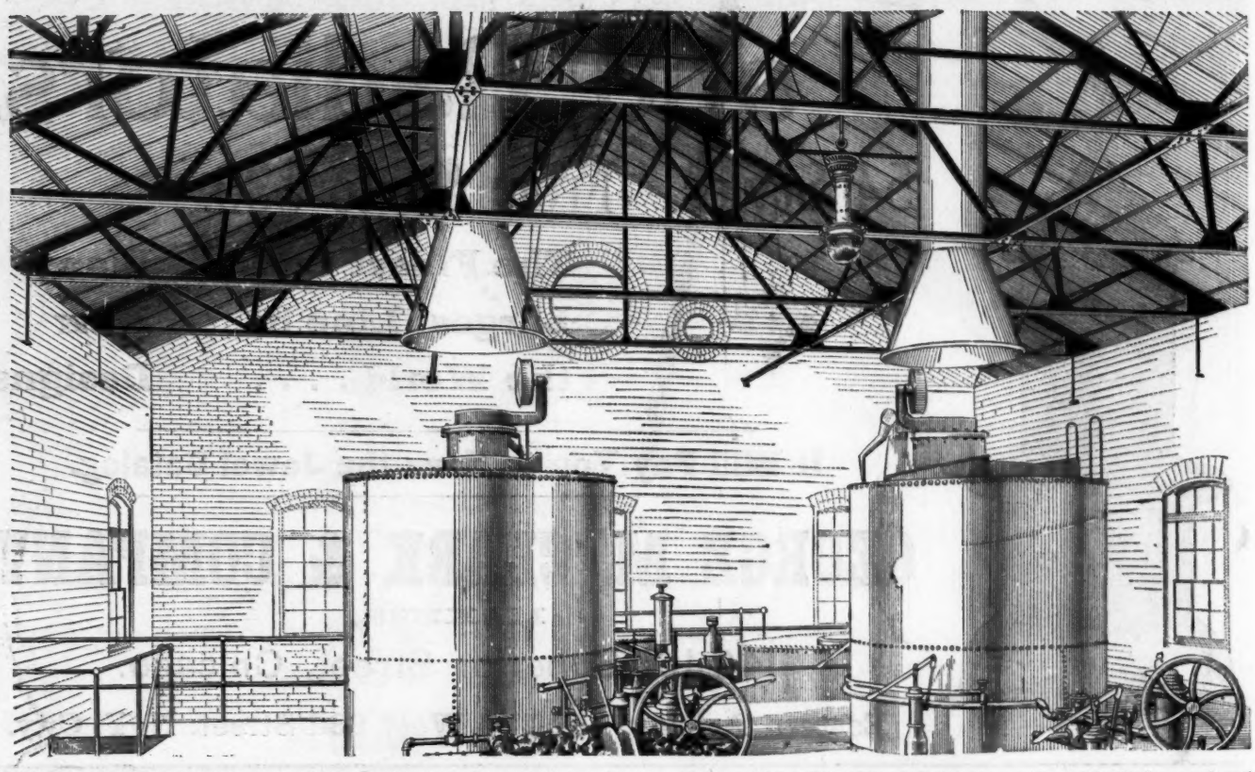

The above illustration is taken direct from a photograph, and shows the construction of an Iron Truss Roof designed and built by us for the Providence Gas Light Company, at Providence, R. I. The building is 40 ft. in width by 100 ft. in length, the side walls being of brick and the roof being entirely of iron—that is, iron trusses and iron purlins covered with corrugated iron. The building is ventilated by our Improved Ventilator, extending the full length of the roof, with side shutters opened and closed by cords from the floor. No woodwork is used in any way about the construction of the building.

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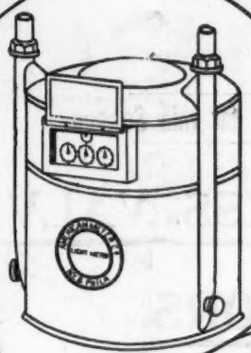
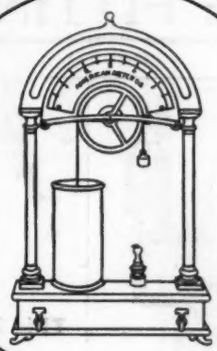
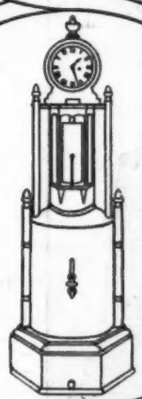
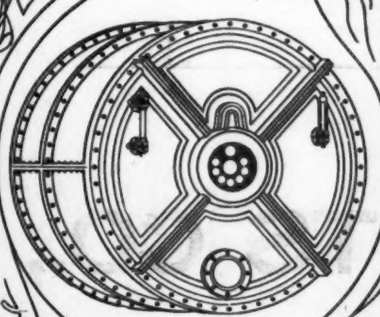




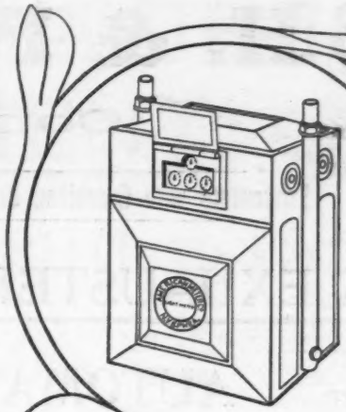


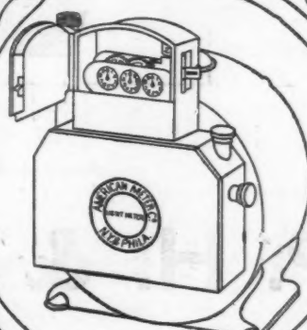


PUBLIC LIGHTING TABLE.

JANUARY, 1896.

Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Table No. 1. Following the Moon. Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Table No. 2. New York City. All Night Lighting. Extinguish.
				P.M	A M.
Wed.	1	No L.	No L.	4.30	6.30
Thu.	2	5.20 PM	7.50 PM	4.30	6.30
Fri.	3	5 20	9.10	4.30	6.30
Sat.	4	5.20	10.30	4.30	6.30
Sun.	5	5.20	11.40	4.30	6.30
Mon.	6	5.20	12 50 AM	4.30	6.30
Tue.	7	5.20 LQ	2.10	4.30	6.30
Wed.	8	5.20	3.20	4.40	6.30
Thu.	9	5.20	4.30	4.40	6.30
Fri.	10	5.20	5.40	4.40	6.30
Sat.	11	5.20	6.20	4.40	6.30
Sun.	12	5.30	6.20	4.40	6.30
Mon.	13	5.30	6.20	4.40	6.30
Tue.	14	5.30 NM	6.20	4.40	6.30
Wed.	15	5.30	6.20	4.50	6.25
Thu.	16	5.30	6.20	4.50	6.25
Fri.	17	5.30	6.20	4.50	6.25
Sat	18	5.30	6.20	4.50	6.25
Sun.	19	8.50	6.20	4.50	6.25
Mon.	20	9.50	6.20	4 50	6.25
Tue.	21	10.50	6.20	4.50	6.25
Wed.	22	11.50 FQ	6.20	5.00	6.25
Thu.	23	1.00 AM	6.20	5.00	6.25
Fri.	24	2.00	6.20	5.00	6.25
Sat.	25	3.10	6.20	5.00	6.25
Sun.	26	4.10	6.10	5.00	6.25
Mon.	27	5.10	6.10	5.00	6.25
Tue.	28	No L.	No L.	5.00	6.25
Wed.	29	No L. FM	No L.	5.05	6.15
Thu.	30	No L.	No L.	5.05	6.15
Fri.	31	5.50 PM	8.10 PM	5.05	6.15





TOTAL HOURS LIGHTING DURING 1896.

By Table No. 1.	Hrs.Min	By Table No. 2.	Hrs.Min.
January	220.40	January	423.20
February	207.00	February	367 40
March	193.00	March	355.35
April	174.10	April	298.50
May	164.00	May	264.50
June	142.10	June	234.25
July	142 10	July	243.45
August	150.50	August	280.25
September	163.00	September	321.15
October	193.10	October	374 30
November	207.00	November	401.40
December	237.30	December	433.45
Total, yr.	2194.40	Total, yr.	4000.00

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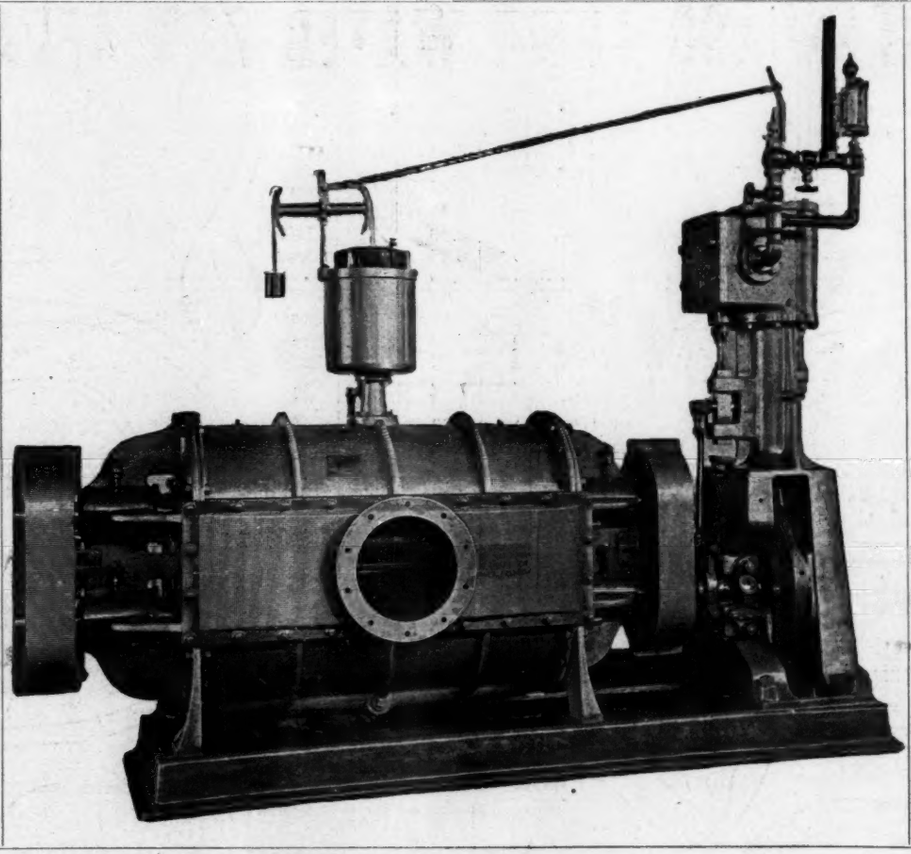

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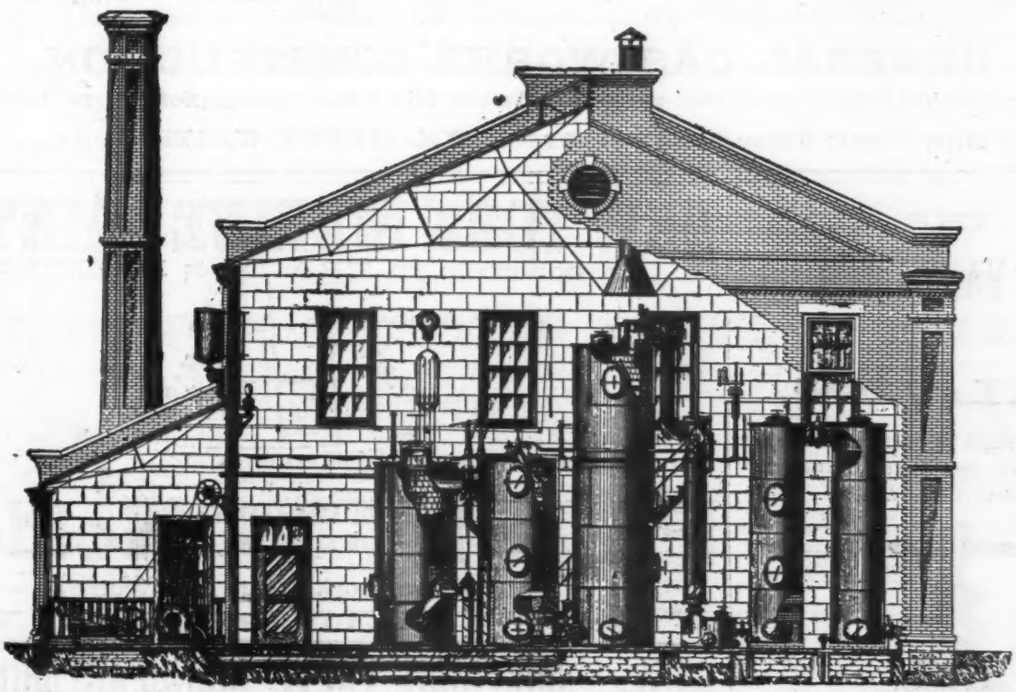

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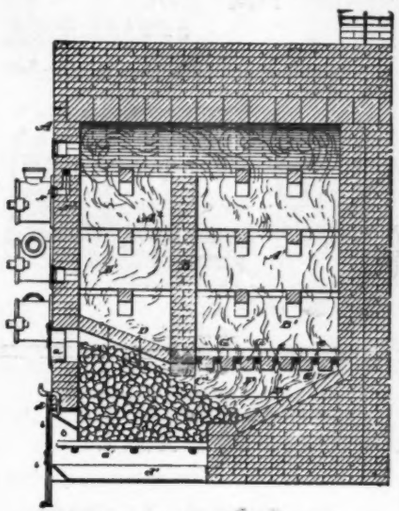

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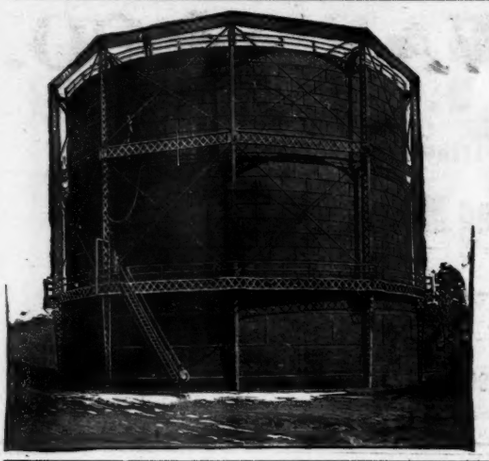

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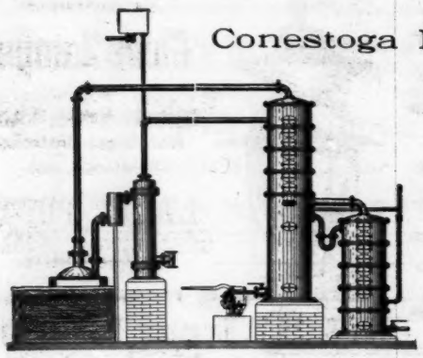

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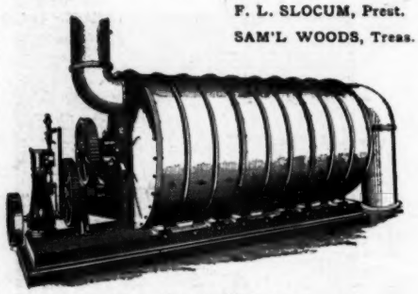

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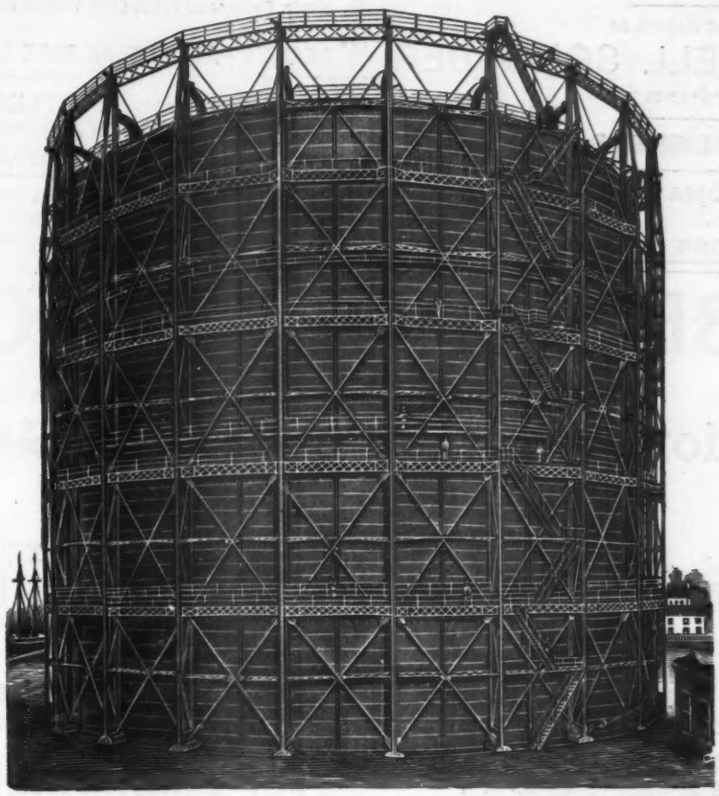

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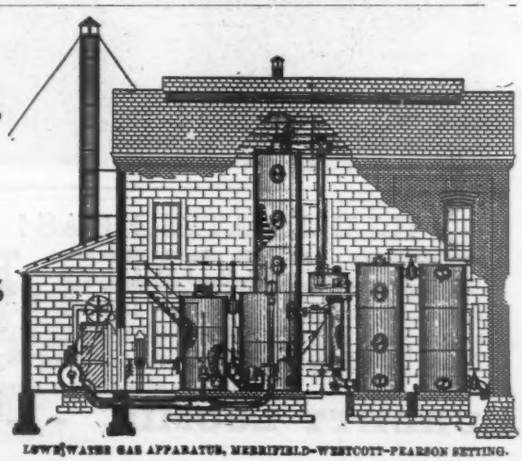

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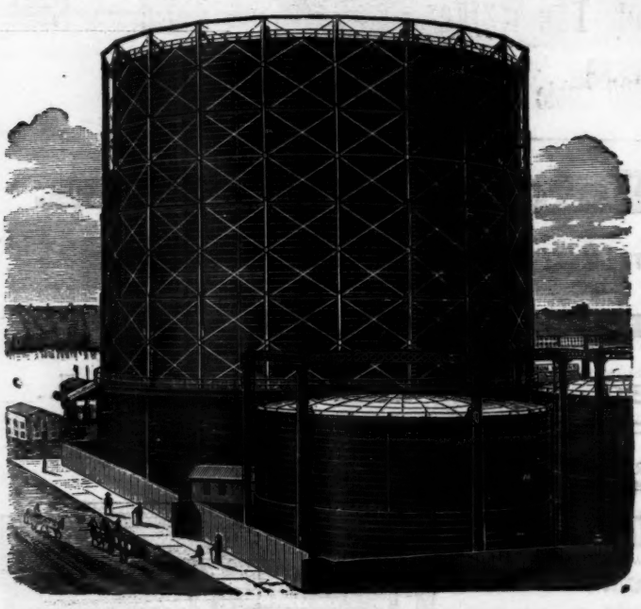

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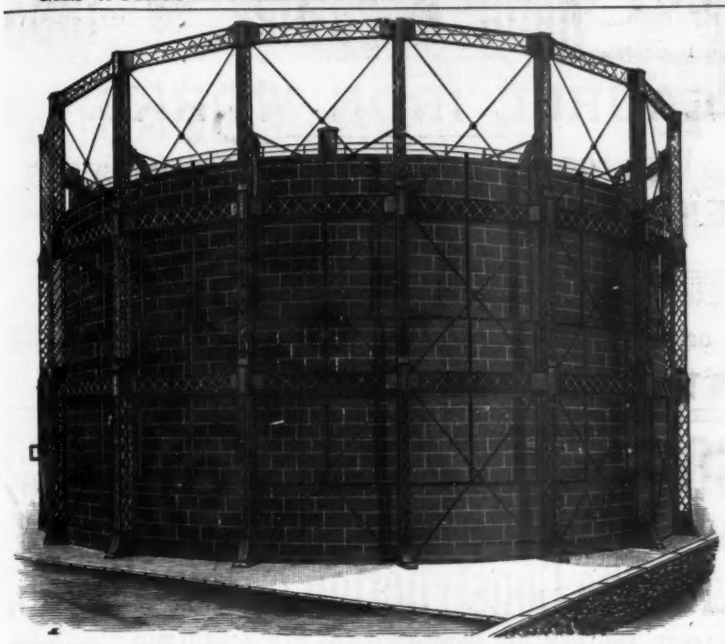

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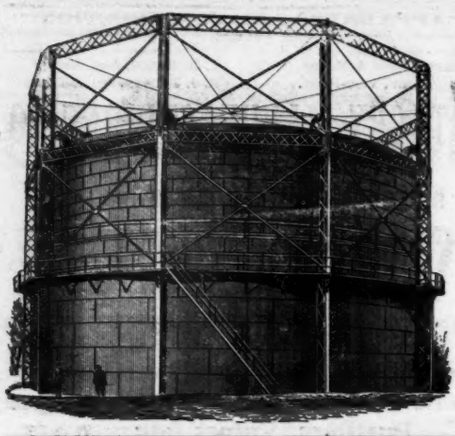

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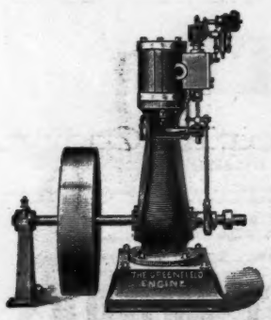

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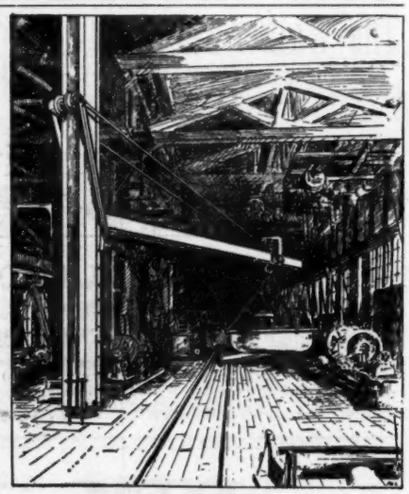

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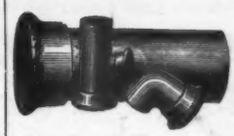

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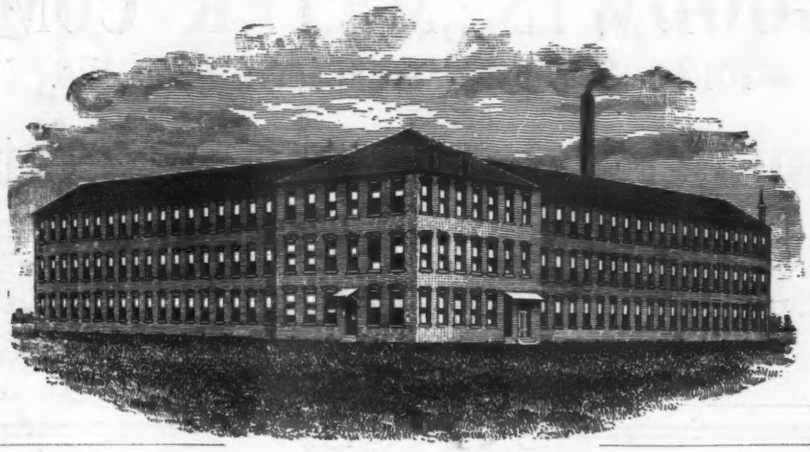

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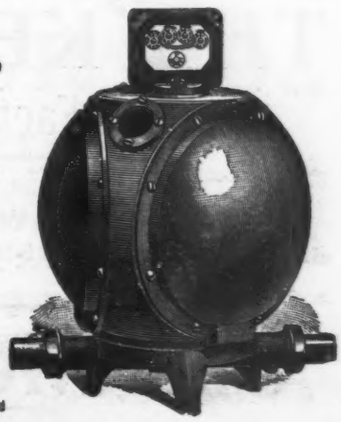

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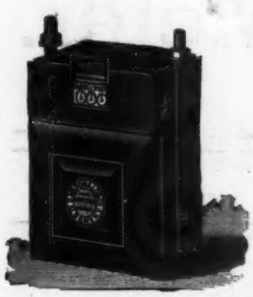

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